Aviation Week

Including **Space Technology**

75 Cents

A McGraw-Hill Publication

December 29, 1958

Pilot Report On MS 760 Jet

•

Power Unit For Space Studied

North American Navaho Fired

Photo of an official flight test of AN/USD 2 drone, U. S. Army Test Station, Yuma, Arizona

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A DEPARTMENT IN THE DEFENSE ELECTRONICS DIVISION

AVIATION CALENDAR

Jan 12-14—Fifth National Symposium on Reliability and Quality Control in Electronics Bellevue-Statler Hotel, Phila.

Jan 12-16—1959 Annual Meeting and Engineering Display, Society of Automotive Engineers, Sheraton-Cadillac and Statler Hotel, Detroit Mich Dr T Keith Glennan, speaker, SAE Annual Dinner, Jan 14

Jan 13-14—Symposium on Cathode Ray Tube Recording sponsored by Systems Development Corp., Engineers Club, Dayton, Ohio

Jan 19-21—11th Annual Convention Helicopter Assn of America, Villa Hotel San Mateo Calif

Jan 21-23—South West Electronic Exhibit, Arizona State Fairgrounds Phoenix Ariz

Jan 26-27—Annual Meeting Assn of Local and Territorial Airlines National Aviation Club, Washington, D C

Jan 26-29—27th Annual Meeting, Institute of the Aeronautical Sciences, Sheraton Astor Hotel, New York N Y Honors Night Dinner Jan 27

Jan 27-29—Fifth Annual Radar Symposium (classified) Rackham Bldg University of Michigan Ann Arbor Mich.

Jan 27-30—15th Annual Technical Conference, Society of Plastics Engineers, Hotel Commodore, New York, N Y

Jan 28-29—Fifth Annual Midwest Welding Conference sponsored by Armour Research Foundation, Illinois Institute of Technology Chicago Ill

Feb 3-5—14th Annual Technical and Management Conference Reinforced Plastics Division, Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago

Feb 12-13—1959 Solid State Circuits Conference sponsored by Institute of Radio Engineers' Professional Group on Circuit Theory American Institute of Electrical Engineers' Committee on Electronics and

(Continued on page 6)

AVIATION WEEK Including Space Technology

December 29, 1958

Vol 69, No 26

Published weekly with an additional issue in December by McGraw Hill Publishing Company James H McGraw (1860-1948) Founder See panel below for directions regarding subscription or change of address. Executive, Editorial, Circulation and Advertising Offices McGraw Hill Building 330 West 42nd Street, New York 36 N Y. Publication Offices 99-129 North Broadway Albany 1, N Y Donald C McGraw President Joseph A Gerardi Executive Vice President L Keith Goodrich Vice President and Treasurer; John J Cooke Secretary Officers of the Publications Division Nelson L Bond President Harry L Waddell Senior Vice President Ralph B Smith Vice President and Editorial Director Joseph H Allen Vice President and Director of Advertising Sales; A R Venezian Vice President and Circulation Coordinator

Subscriptions are solicited only from persons who have a commercial or professional interest in aviation including missiles and space technology Position and company connection must be indicated on subscription order

Single copies 75¢ Subscription rates—United States and possessions, $7 one year Canada $8 one year All other countries, $20 one year

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Subscribers Send correspondence and change of address to Fulfillment Manager Aviation Week 330 West 42nd Street, New York 36, N Y. Subscribers should notify Fulfillment Manager promptly of any change of address giving old as well as new address including postal zone number. Enclose recent address label if possible Allow one month for change to become effective

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AVIATION CALENDAR

(Continued from page 5)

University of Pennsylvania, Philadelphia

Feb 12-13—Computer and Data Processing in Industry conference for manufacturing and engineering management, Purdue University Lafayette Ind

Feb. 14—Meeting on Short Range Navigational Aids, International Civil Aviation Organization. International Aviation Bldg Montreal Canada

Feb 21 22—13th Annual Pacific Coast Mid Winter Soaring Championships Torrey Pines Gliderport San Diego Calif

Feb 26-March 1—1959 Engineering Exposition Balboa Park San Diego Calif Address inquiries to 422 Land Title Bldg San Diego, Calif

March 3 5—1959 Western Joint Computer Conference sponsored by Institute of Radio Engineers American Institute of Electrical Engineers and Assn for Computing Machinery Fairmont Hotel San Francisco Calif

March 5 6—Flight Propulsion Meeting (classified) Institute of the Aeronautical Sciences Hotel Carter, Cleveland Ohio

March 5-7—Western Space Age Conference and Exhibit For information Domestic Trade Dept., Los Angeles Chamber of Commerce 404 South Bixel St Los Angeles 54 Calif

March 8 11—Engineering meeting on the turbine in action sponsored by Gas Turbine Division of the American Society of Mechanical Engineers, Cincinnati Ohio

March 16-20—11th Western Metal Exposition and Congress American Society for Metals Pan Pacific Auditorium and Ambassador Hotel Los Angeles Calif

March 23 26—National Convention Institute of Radio Engineers Coliseum and Waldorf Astoria Hotel New York N Y

March 31 Apr. 2—Polytechnic Institute of Brooklyn's Ninth International Symposium Subject Millimeter Waves Auditorium Engineering Societies Bldg. New York N Y Cosponsors Department of Defense Research Agencies and Institute of Radio Engineers

March 31 Apr 3—National Aeronautic Meeting Society of Automotive Engineers Hotel Commodore New York, N Y

Apr 5 10—1959 Nuclear Congress Municipal Auditorium Cleveland Ohio For information Engineers Joint Council 29 West 39th St New York 18 N Y

Apr. 7 10—1959 Welding Show and 40th Annual Convention American Welding Society International Amphitheatre and Hotel Sherman Chicago Ill

Apr. 12 19—Air Force Assn's World Congress of Flight, Las Vegas, Nev

Apr. 18 22—Annual Meeting American Society of Tool Engineers Schroeder Hotel, Milwaukee Wis

Apr 22-24—1959 Annual Meeting Institute of Environmental Engineers, LaSalle Hotel Chicago Ill

May 4-6—National Aeronautical Electronics Conference Institute of Radio Engineers, Biltmore Hotel Dayton Ohio

May 4 7—Fifth Annual Flight Test Instrumentation Symposium sponsored by the Instrument Society of America Seattle Section, Olympic Hotel Seattle Wash

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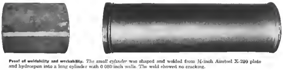

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December 29, 1958

Aviation Week

Including Space Technology

Vol 69, No. 26
Member ABP and ABC

EDITORIAL OFFICES: New York 36—330 W. 42nd St Phone: LOngacre 4-3000 (Nights LO 4-3035) Washington 4 D C—National Press Bldg. Phones NAtional 8-3414 REpublic 7-4630 Los Angeles 17—1125 West Sixth St. Phone: HUntley 2-5450 Dallas 1—1712 Commerce St Phone Riverside 7-5217 European Office—1 rue du Temple, Geneva Switzerland Phone: 32-35-63

COVER USAF-North American XSM-64 leaves its launch stand at Atlantic Missile Range, Cape Canaveral, Florida. Mobile erector vehicle can be positioned from horizontal to vertical. Development program of this intercontinental cruise missile produced missile and submarine inertial guidance systems powerplants for Atlas, Thor, Jupiter and Redstone (AW Nov 17, p 20) RISE project to gain Mach 3 temperature and pressure data for B-70 and F-108 was canceled after two of five Navahos were flown. Boosters may be used in space projects (see p 23).

PICTURE CREDITS
Cover—USAF 20 21 22 23 41 46 47—USAF; 24—Bell Helicopter Corp 25—Sud Aviation; 31—Convair; 32—Vickers Armstrongs 33—(top) Fairchild (bottom) Fokker 45—Rocketdyne 53 54—Lockheed 47—Boeing 58 59 60—Hughes Aircraft Co; 62—Sperry Rand 63—Sperry Gyroscope; 64—(top) Erwin J Bulban (bottom) Corning Glass Works 66 67, 69, 70 71 73—Beech Aircraft, 74—Saviolo

75,166 copies of this issue printed

Orbital Atlas—Preview of Future

The aura of fatuous and semi-accurate information with which the White House and some top-level Defense Department officials have attempted to surround the successful rocket flight of the Air Force Atlas missile manufactured and fired by Convair should not obscure the genuine technical significance of this achievement.

We recall the smug statement of Sherman Adams, then the top presidential assistant, just after the Soviet's Sputnik I went into orbit that "we are not playing a basketball game in outer space." The public information aspects of the Atlas satellite more than a year later suggest more of the technique of a walnut shell and pea artist at a country carnival. This type of handling placed the responsible officials in the ridiculous position where a Russian—Leon Sedov, head of the USSR space commission—was dispensing the most accurate data on the orbital weight of Atlas compared with the Sputnik.

We will explore this deliberate manipulation of the news under the guise of military security in more detail in later issues.

Technical Achievement

Now we would like to concentrate on the technical aspects of this achievement. The successful flight of the Atlas into orbit marks the beginning of a new chapter in U. S. space exploration efforts. Full credit should go to the Air Force for sponsoring the Atlas missile development program and to Convair for its truly remarkable performance during the year in bringing the Atlas to a high degree of reliability, not only in its capacity as an intercontinental ballistic missile capable of delivering megaton-sized warheads over a 5,500 nautical-mile range but also to the point where it is ready to take its place as the workhorse of future space exploration. The self-seekers who attempted to erase the credit of both USAF and Convair from this achievement will find their purloined glory short-lived when the genuine technical history of this era is written.

The Atlas, with its initial triple-engined rocket thrust of 360,000 lb., is the first propulsive system capable of lifting really significant payloads into space. It will serve as the initial booster for the Mercury program aimed at getting a manned capsule into orbit, the USAF Sentry reconnaissance satellite program and, as Convair's Krafft Ehricke proposed many many months ago, also could be used as the first multi-manned space vehicle and as a space supply freighter.

For the Convair engineers in the San Diego Astronautics Division and the Convair test crews at Cape Canaveral, the shot of Atlas 10-B into orbit was an exciting climax to a year of rugged grinding that produced results commensurate with the extraordinary effort they expended.

The combination of radio control and inertial guidance developed by the General Electric Co. and Burroughs also will play an important part in the Atlas use for space exploration although a pure inertial system will eventually be used for its purely military use as an ICBM.

Communication Experiments

The communication experiments with the Atlas satellite also have broken significant new ground in what may eventually become one of the most useful functions of satellites for both military and civilian purposes. As detailed elsewhere in this issue (see page 19) these experiments point the way toward opening a broad new horizon of communication techniques and expanding communications volume out of the frequency strait jacket that now threatens an early saturation with conventional techniques. The Army Signal Corps has earned kudos for its work in this area.

The year now ending has seen important changes in this country's attitude toward space exploration. From the post-Sputnik smugness typified by Sherman Adams, we have passed through some hard and sober efforts to organize an effective space program while, at the same time, frantically attempting to make some sort of spectacular showing that would erase the onus of the admittedly impressive Soviet Sputnik trio. The orbital payloads possible with the Redstone boosters and the moon probe instrumentation limited by the Thor and Jupiter initial stage engines were aimed more at international effect than at sound scientific achievement, although they did provide useful information from both success and failure.

However, the democratic process ground slowly but surely, and by year's end the National Aeronautics and Space Administration had been authorized, organized and was well on its way toward organizing a scientifically sound, financially feasible and competitively paced national space program that should eventually yield a rich harvest of new knowledge that can be usefully applied for both military and civilian purposes.

The propaganda antics surrounding the initial Atlas satellite belong to the era of frantic circus stunts aimed at quick and dirty substitutes for well-planned scientific programs, while the technical achievements of the Atlas orbit provide a heartening preview of what can be done during the next year.

—Robert Hotz

WHO'S WHERE

In the Front Office

Robert E Lewis, president, Sylvania Electric Products, Inc, New York, N Y, succeeding **Don G Mitchell**, who continues as board chairman Under plan for the merger of Sylvania into General Telephone Corp, Mr Mitchell will become president of the combined company, which will be known as General Telephone & Electronics Corp

Harper Woodward, a director, Vitro Corporation of America, New York, N Y., replacing Laurance S Rockefeller

Raymond C Blaylock, vice president engineering and **Gifford K Johnson**, vice president production elected directors, Chance Vought Aircraft, Inc., Dallas Tex

Sir Wilfred Neden and **Frank Taylor**, directors, British Overseas Airways Corp Also **Keith Granville**, deputy managing director of BOAC, will succeed **Sir Francis Brake**, retiring, on the main board Sir Francis will continue to serve on the BOAC Associated Companies board

Bernard J Shallow vice president-sales, and **Franklin C Clark**, vice president human relations, Marlin-Rockwell Corp, Jamestown N Y

George W DeSousa, vice president marketing Semiconductor Division Hoffman Electronics Corp, Los Angeles, Calif

Francis S. Napoli, vice president manufacturing, Dumont Aviation Associates, Long Beach, Calif and general manager of Du Air Screw Corp, Gardena, Calif

Walter L. Smith, assistant to the president Chase Brass & Copper Co, Waterbury Conn **Gilbert R Boutin** succeeds Mr Smith as vice president-operations

James Patrick Gleason, Assistant Administrator for Congressional Relations, National Aeronautics and Space Administration Washington D C

Dr Roderic M Scott vice president of Perkin-Elmer Corp., Norwalk Conn, has been named head of the Engineering and Optical Division's photo reconnaissance activity

William V Groff, secretary treasurer, Air Carrier Engine Service, Inc, Miami

Robert Chilton, controller and administrative manager, Airen, Inc, Woodside, N Y

Maj Gen Oliver K Niess appointed Surgeon General of the Air Force

M Whitney Nesbitt, vice president sales, Pesco Products Division, Borg Warner Corp, Bedford Ohio

Read Adm Almon E Loomis, Commander Carrier Division 19 Also **Rear Adm David J Welsh**, Commander Carrier Division Five **Rear Adm. Thurston B Clark**, Commander, Fleet Air Wings, Atlantic Fleet, and Commander, Fleet Air Wing Five

Honors and Elections

H Myrl Stearns, president of Varian Associates, has been named a Fellow of the Institute of Radio Engineers for "his contributions in the fields of microwave tubes and Doppler radar"

(Continued on page 75)

INDUSTRY OBSERVER

▶ Preliminary specifications on beryllium heat sink for National Aeronautics and Space Administration's manned capsule program (AW Nov 24, p 28) call for a disk one inch thick, seven feet across and with a 126-in radius of curvature Figures were spelled out by competitors for the contract in their requests to beryllium fabricators for cost estimates

▶ Monkey sent aloft recently in a Jupiter nose cone experienced deceleration of about 40G for a very short time on re-entry and acceleration loads of about 10G on takeoff for period of less than 100 sec Since the monkey was a tropical animal accustomed to about 78F temperature, a seven-watt light bulb was used to heat his space compartment. Weightlessness period was about 8.3 min. rather than the 13.3 min. reported earlier (AW Dec. 22, p. 23).

▶ New version of Navy's Sidewinder air-to-air missile will include an all-electronic guidance system designed by Texas Instruments, will be used on missions where weather or other considerations make the infrared guidance of the present system ineffective. Designation of the new version is Sarah

▶ Firms associated with Lockheed Aircraft Corp in the Air Force competition for a new early warning and control aircraft include Allison Division of General Motors Corp, engines, General Electric Co., radar, General Precision Equipment Corp, navigation, Hazeltine Corp., data processing displays, Hughes Aircraft Co., communications and data link, and Lockheed's Missile Systems Division, automatic checkout equipment. Allison's T61 5,000 eshp two-spool turboprop engines have been specified by USAF in the competition (AW Nov 17, p 23).

▶ North American Aviation has selected its own Autonetics Division to develop the flight control subsystem for the Mach 3 F 108 interceptor and B 70 bomber despite earlier objections to its choice raised by Wright Air Development Center engineers (AW Dec 1, p 30) Autonetics Division's experience in developing the flight control for the Navaho missile made it a strong contender, but North American's choice may bring criticism from other flight control manufacturers

▶ Choice of avionic manufacturer to develop electronic countermeasures subsystem for the B-70 will depend upon the results of extensive facilities-competence questionnaire Air Force has asked North American to submit to three ECM bidders—General Electric, Radio Corp of America and Westinghouse Electric Corp. Westinghouse was North American's first choice (AW Dec. 8, p 34), but Wright Air Development Center's Weapons Guidance Laboratory did not concur because it reportedly feels the company is a relative newcomer to the electronic countermeasures field

▶ Current price of Boeing Bomarc interceptor missile is approximately $700,000 each, minus warhead which costs about $200,000 each If quantity of 2 500 or more is ordered, price is expected to drop to about $300,000 per missile.

▶ Russia is continuing to push development of a practicable ornithopter with experiments under way at Riga, Kiev, Kharkov and Kazan The second Soviet scientific and technical conference on ornithopters is scheduled to be held in Moscow early next year Representatives of Communist satellite nations, as well as Russian designers, are scheduled to attend.

▶ Russian astronomers are overcoming the handicap of smaller telescopes by using electronic image converters and extra manpower Biggest reflector now is a 50 in telescope taken from Germany after World War II, but the foundation for a 102-in telescope is being laid at the Crimean Astrophysical Observatory and a 236 in telescope is planned some years from now Pulkova Observatory near Leningrad completely rebuilt since its destruction during the war, has a staff of 400, of which 150 are scientific personnel By contrast, U S observatories such as Mt Wilson and Palomar have obtained far more data than their staffs can reduce

Washington Roundup

Pyle Appointment

Despite flurries of rumors to the contrary during recent weeks, Civil Aeronautics Administrator James T. Pyle will be named—and will accept—the post of Deputy Administrator of the new Federal Aviation Agency as first predicted by AVIATION WEEK (AW Aug. 25, p. 34). Only steps remaining to make the appointment official are the formal announcement by President Eisenhower and confirmation of Pyle by the Senate.

Meanwhile, William B. Davis, former CAA deputy administrator to Pyle, has been made director of the FAA's Bureau of Flight Standards. David D. Thomas, former head of CAA's office of air traffic control, has been appointed director of FAA's Bureau of Traffic Management. Alan L. Dean, now of the Bureau of the Budget, will take over as the FAA Assistant Administrator of Management Services.

Make or Buy

Impact on industry of Air Force's new "make or buy" procurement instruction (AW Oct. 6, p. 26) requiring contractors to obtain approval of what is to be manufactured in-plant and what is to be subcontracted depends upon its ultimate administration. Some observers look on it as no more than a formalization of present USAF practices aimed at preventing the construction of new government-financed facilities when there already are suitable facilities. Others believe it arms small business and other industrial interests as well as congressional committees with an important weapon with which to pressure USAF into requiring aircraft firms to subcontract.

President's Budget Plans . . .

President Eisenhower's plans call for a reduction in government expenditures coupled with an increase in taxes in an effort to balance the federal budget at a figure of $77 billion. A White House announcement last week reported: "A balanced budget will be an important and welcome assurance to the people of the country and the world that our government is determined to live within its means . . . and to fulfill American responsibilities of world leadership."

The recent economic recession wrecked Administration plans for a balanced budget in Fiscal 1959, and estimates are that the government will be about $12 billion in the red by June. Defense expenditures in the new budget will be around $41.6 billion, a slight increase over this year's figure of approximately $40.8 billion. Such an increase, however, would hardly adjust for the declining purchasing power of the dollar.

. . . vs. Soviet Budget

Soviet Russia's 1959 budget plans also were released last week. They called for an expenditure of 707.2 billion rubles, an increase of more than 10% over 1958. The total is more than $176 billion at the official rate of exchange, but it is impossible to compare it with the U. S. figure because the major portion of Soviet industry is financed through the government budget and Russian practice is to use overlapping entries in their gross ledger. Soviet Minister of Finance Arsenyi G. Zverev told the Supreme Soviet that he expects that total government revenue during the year will be over 732 billion rubles, leaving a 9% surplus.

Outright military expenditures were listed at 96.1 billion rubles, or less than 14% of the total, but a large portion of the 484.3 billion rubles slated for investment in the government-controlled industry has direct military importance. Other categories of the Soviet budget also include funds that will be used solely to increase Russian military power. Planned science expenditures are up more than 12% to 27.3 billion rubles, and a major effort is being initiated to put research on a self-supporting basis. Research institutes will receive only 24 billion rubles of the 27.3 billion.

Disarmament Inquiry

Sen. Hubert Humphrey, chairman of the Senate Foreign Relations Disarmament Subcommittee, will attempt to stir congressional interest on disarmament matters during the coming session. Hearings before his subcommittee two years ago fizzled through lack of interest. These are some of the problems on which Humphrey says he plans to focus:

- **What should U. S. disarmament policy be** if an international treaty to ban nuclear tests comes into force?
- **Has the U. S. been wise in the past** to base so much of its defense effort on nuclear weapons and has it been wise for U. S. disarmament policy to stress primarily the control of nuclear weapons?
- **Should the emphasis on nuclear** weapons be modified?

Senate Space Appointees

First permanent staff members of the Senate Committee on Aeronautical and Space Science are Kenneth E. Belieu, staff director, and Dr. Glen P. Wilson, chief clerk. Belieu has served as professional staff member of the Senate Armed Services Committee for the last three years following his retirement as senior signal officer in the Army. He also has served as assistant to former Army secretaries Frank Pace Jr., and Robert T. Stevens. Dr. Wilson is now serving as coordinator of technical information for the Senate Committee on Space and Astronautics, which ends its activities when the new permanent committee takes over.

Weather Analysis

Federal Aviation Agency has awarded a $97,905 contract for analysis of the aviation weather system and methods of improving it. Technical Operations Inc., Burlington, Mass., study is scheduled to be completed by next Oct. 31. Primarily, the analysis will concentrate on means of accelerating weather forecasts to aid in the design of the modernized air traffic control system and operational procedures agency is developing.

New Ditching Procedure

U. S. airlines are cooperating with the Coast Guard in testing a new radio communications plan designed to aid distressed aircraft in making ditching arrangements by allowing the crew to talk directly with nearby ships. Key to the plan is airborne radio voice equipment operating on 2182 kilocycles. Coast Guard stations advise the disabled aircraft which vessels are in their area, then alerts these ships to the difficulty. When the aircraft is within 300 mi. of a ship, voice contact can be made between the two units.

—Washington staff

Satellite Researches Space Techniques

Communications experiments, feasibility of Atlas as manned vehicle explored by 'Score' satellite.

By Evert Clark

Washington—Number of significant communications experiments were being carried out last week by a relay system sent into a short life orbit in an Atlas missile, the first large satellite vehicle to be put into space by the U S

Orbiting of the 8,750 lb intercontinental missile with its 168-lb payload from Cape Canaveral, Fla, has these objectives

• **Communications.** The satellite and a network of four main ground stations are testing a variety of combinations of voice and teletype transmission and reception Success of these experiments confirms the feasibility of using courier satellites for reliable round-the world communications

• **Vehicles** Feasibility of using the USAF Convair Atlas as a space vehicle was proven on the first attempt Atlas is slated to be the booster for launching a manned satellite (AW Nov 24, p 28) and for launching the Sentry reconnaissance satellite

It also is the strongest contender for use in a number of less important projects in the near future Launching of the Army Signal Corps—RCA relay system provided a test of the stresses encountered in a satellite shot as well as the feasibility of guiding the missile into orbit General Electric-Burroughs radio inertial system used will be replaced by an Arma all-inertial system for missile applications of the Atlas, but the Atlas was used as the main space launcher and probably other Atlas space vehicles will continue to use the GE Burroughs system. This is the first U S satellite to be controlled by its guidance system throughout its powered flight

• **Propaganda** Both the launching and the initial communications tests were handled in such a way as to achieve maximum world-wide publicity Atlas outweighs the hardware previously put into orbit by the U S on any shot by most of its 8,750 lb Heaviest weight prior to the Atlas was the small Vanguard I test satellite plus its third-stage rocket, a total of about 53 lb Purpose of the launching was a well kept secret even from many of the launch crew Reporters who inquired about the shot were specifically told that it was to be a routine research and development test First announcement of the true purpose was made by President Eisenhower after the missile was in orbit First message transmitted by the communications system was the President's Christmas message to the world, which had been recorded on erasable tape and stored in the instrument package The message said

"This is the President of the United States speaking Through the marvels of scientific advance my voice is coming to you from a satellite circling in outer space My message is a simple one Through this unique means I convey to you and to all mankind America's wish for peace on earth and good will toward men everywhere"

Project is called 'Score' for Signal Communications by Orbiting Relay Equipment

Plan to put an Atlas into orbit was arrived at by Defense Department's Advanced Research Projects Agency and Convair Division of General Dynamics Corp many months ago USAF's Ballistic Missile Division of Air Research and Development Command, the Space Technology Laboratories Inc, and the Army Signal Corps Research and Development Laboratories were assigned to carry it out Firing had to await a full-range firing of Atlas so military capability could be demonstrated before its space capability was tested

Project officially was firmed up last Aug 27 and Atlas 10-B was diverted from Convair's San Diego production line to a special Atlas modification line for final configuration modifications Payload was installed at Cape Canaveral

The Atlas was launched at 6 02 p m EST Dec 18 Standard propulsion, fuels and guidance systems were used, although some fuel was added and burning time was lengthened by some 13 sec to approximately 271 sec

Atlas achieved an initial apogee of about 928 mi and initial perigee of about 114.5 mi based upon observations up to the 12th circuit of the earth Period of orbit was 100 min Apogee and perigee anticipated were 118 mi and 625 mi, respectively, indicating that the orbit achieved was slightly less circular than desired

Velocity sought at burnout was 17,000 mph Orbits lie between 32 deg N latitude and 32 deg S latitude Expected lifetime for the satellite was 20 days

Turn Into Orbit

Final turn into orbit was preprogrammed into the inertial portion of the guidance system The Burroughs computer functions during the command portion of the flight

The 244,000-lb Atlas, lightened slightly by modification of its basic instrumentation, was launched vertically and curved into a trajectory normal to a ballistic missile flight When it began to depart from this trajectory technicians who were not privy to the secret of the mission repeatedly and unsuccessfully pressed the manual guidance cut-off button only to learn later that it had been disconnected, according to Maj Gen Bernard A Schriever BMD commander

Two Rocketdyne booster chambers of 165,000 lb thrust each burned for 127 sec, carrying the missile over a horizontal distance of 33 mi Booster package dropped off The Rocketdyne sustainer, which is ignited on the ground and produces 60,000 lb thrust, burned for about 271 sec At its cutoff, Atlas had traveled 390 mi horizontally from its launch spot and had programmed into orbit with an azimuth of about 107 deg and a velocity slightly higher than necessary for a successful orbit

Regular Atlas expulsion system used to rid the missile of unused fuel at thrust termination was carried, and apparently worked successfully if any fuel remained

Payload was carried in two duplicate packages in what normally are the guidance pods on the sides of the Atlas' body Each pod contained a recorder radio transmitter and receiver, control unit, batteries and Minitrack beacon transmitter Communications transmitters used 132 435 and 132 095 megacycles and produced eight watts of power Minitracks used 107 94 and 107 97 mc and operated continuously

System was developed by Army Signal Corps and Radio Corp of America's Astro-Electronics Products Division Other contractors include Eagle Picher Lead Co for the zinc silver oxide batteries Potter & Brumfield Inc, special relays Radiation Inc, for ground station antennas, Radio Frequency Laboratories Inc, for teletype multiplexers for ground stations Convair for antennas on the Atlas

Army ground stations are located at Prado Dam Basin, Corona, Calif, Army Electronic Proving Ground, Ft Huachuca, Ariz, Ft Sam Houston, Tex, and Ft Stewart, Ga They consist of antenna arrays and five standard trucks Multiplexers handle 60 words/min on each of seven teletype channels plus one voice communication Recorder in the satellite can store about 1,680 telegraphic words in its 4-min storage capacity Early experiments included

• **Transmission by voice of President** Eisenhower's message This was received by a Cape Canaveral station after it triggered the satellite on Dec 19 Later that day, other stations received both the voice and teletype transmissions of the message Tumbling of the Atlas causes short fades in the signals received at earth but generally has not prevented reception

• **California station interrogated on the** 27th pass with only fair reception Station then sent control signals to condition satellite for direct relay and transmitted its own identification plus the President's message in teletypewriter code Texas station received these signals with two short fades, and Arizona and Georgia stations received some signals This was the first successful relay of teletype signals through an orbiting station

• **California signalled satellite** on 28th pass to clear the tape record Station then transmitted in voice for recording aboard the satellite an identification of itself plus the President's message Texas interrogated the satellite and both Texas and Georgia received the voice loud and clear Georgia station then interrogated the satellite and again received the message This was the first successful courier communication from earth to satellite to another earth station at a later time

• **California sent a four minute mes**sage then had it retransmitted by interrogating the satellite Texas and Arizona heard the message, but the Georgia station heard it only briefly Message, both in voice and teletype code, was to be carried overnight

• **Tape in satellite was cleared** by Georgia station on the 40th pass Station then sent the President's message in each of seven simultaneous, multiplexed teletype code transmissions, for storage in the satellite Station then triggered the satellite and received excellent teletypewriter copy so long as the satellite remained within range This was the first successful multi channel teletype transmission by delayed repeater technique from earth-to-satellite-to-earth

• **California station interrogated** early on 41st pass in order to obtain effect of decreasing distance on quality of reception Initially, five channels of teletypewriter messages were received All seven improved as Atlas moved nearer to California Texas cleared the tape and reloaded it with the same seven messages Georgia triggered the satellite, and both Georgia and Texas copied all seven channels Thus California received messages dispatched from Georgia on the 40th pass, and Georgia received traffic dispatched from the Texas station

• **California recorded into the satellite** by voice and teletype on the 42nd pass beginning at about 4 35 p m Texas triggered at about 4 43 p m, and Arizona, Texas and Georgia received with varying degrees of success

• **On the 54th pass**, while Atlas was at 800 mi over the Pacific, Army engineer Thomas G Wolstencroft at Ft Monmouth, N J, spoke through a direct circuit from Monmouth to the California station and into the satellite His words identifying and describing the experiment, were followed again by the President's message in voice and code Texas then triggered the satellite and all four stations received it near perfectly Texas triggered again and all four stations again received parts of the transmission

Soviets View 'Score'

Washington—Weights of the carrier rockets that went into orbit along with Soviet Russia's three Sputniks was "considerably more than four tons" in each case, according to Soviet scientist Leonid Sedov U S estimates based on tracking had put the weights for the rockets alone at about 7,000-8,000 lb

Sedov, chairman of the USSR Academy of Science's space flight commission, was interviewed by Tass following launching by the U S of its Score communications satellite, an Atlas hull with instrumentation incorporated

Sedov compared the Atlas payload of some 168 lb with Sputnik I's 184 lb, Sputnik II's 1,118 lb and Sputnik III's 2,919 lb and pointed out that in all three Sputnik shots the final stage rockets also orbited He also said the perigee of Sputnik I—140 mi—was higher than the Atlas perigee—114.5 mi—and the life of the detached satellite was much longer

Sputniks I and III were not attached to their carrier but Sputnik II carrying a dog passenger was

Bold Orion Proposal

Washington—Martin Co. version of the Bold Orion air-launched ballistic missile test vehicle (AW Dec. 22, p 22) uses a highly modified Thiokol Sergeant engine for its first stage and a highly modified Allegheny Ballistics Laboratory Vanguard engine for its second stage First successful firing of a one stage Lockheed-Convair Bold Orion test vehicle from a Convair B-58 was accomplished over the Atlantic Missile Range on Dec. 19

Score's Significance

Washington—Score satellite has confirmed feasibility of using communication courier satellites to provide reliable round the world transmission of voice, teletype and television

World-wide radio communications presently must operate in the high frequency (HF) band which is highly congested and subject to periodic atmospheric outages Communication courier satellites can operate in the ultra high frequency and microwave region, otherwise limited to moderately short ranges, which offer more available radio spectrum and immunity to atmospheric outages At these higher frequencies, sufficient bandwidth can be obtained to handle wideband television

With communication courier satellites, the ground station transmits the message as it comes within line-of sight range

Message is stored on tape recorder in satellite, transmitted back to earth when satellite passes over another ground station

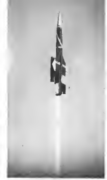
This type of satellite relay has several important advantages, some disadvantages, relative to the simple reflecting type satellite relay (AW Oct 20, p. 85) The latter requires only a large reflecting surface to bounce signals from one ground station to another, much like the ionosphere reflects HF radio signals Transmission is instantaneous but range is limited by the altitude of the satellite

The courier type satellite must carry one or more radio transmitters, receivers and tape recorders plus electric power supply Long-life power supplies, probably employing nuclear cells and/or solar cells, will be required to give the courier a sufficient life to justify its cost

However, the courier type satellite has important military advantages of providing relatively secure (private) communications unlike the passive reflector type which transmits signals over a wide area

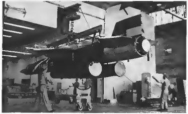
Signal transmitted to courier satellite, and stored on its tape recorder, normally would be transmitted back to earth only when satellite receives authorized command signal. However unless suitable precautions are taken unfriendly ground stations could interrogate courier satellite to receive its message and "overwork" it so its power supply will be too run-down to operate when over friendly ground stations To prevent this will require use of sophisticated command coding possibly a timer which will allow interrogation only during pre-selected times

BOMARC IM-99A climbs vertically from launching enclosure after firing, stabilized in this phase by its gimbaled booster engine



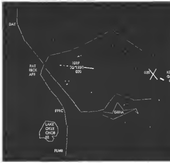
SMOKE from ramjets is from ignition flares

BOMARC IM-99A missile is shown as it is lifted from its exerciser to be transported to the launching site Glass fiber radome and chopped delta planform can be seen clearly



IM-99A MISSILE will be followed by Super Bomarc IM-99B which will have a range of 400 mi. and speed of Mach 3.5 Missile is loaded on transporter (bottom).

Bomarc Demonstrates Effectiveness in Area Defense



SITUATION display generated by the Kingston computer outlines Florida coast and test range limits in dashed lines, labels geographical points and target tracks with identification symbols Drone track is at right near "X", the predicted interception point Bomarc track from Patrick AFB is at center Data beside drone track is "K" for hostile, time of intercept, "G" for quality of radar track, and track identification number

By James A Fusca

Kingston, N. Y.—How effective the Boeing Bomarc surface-to-air missile is as an area defense weapon against manned aircraft and air-breathing missiles was demonstrated here in the weapon system's first public showing

Under the direction and control of signals generated by a large SAGE-type digital computer located in Kingston, N. Y., a Bomarc IM-99A missile was automatically readied and launched from the Air Force Missile Test Center at Cape Canaveral, Fla., about 1,500 mi. away

The missile was fired against a QB-17 drone flying about 120 mi. downrange Midway in the flight to the target interception point, the missile was ordered by the computer to disengage the QB-17 and was assigned to a QF-80 drone target flying about 75 mi. to the northeast The Bomarc accepted the reassignment and successfully intercepted the new target, passing close enough to it to destroy it if the missile had carried warhead and proximity fuze

The significance of the series of 10 Bomarc firings to date under control of the Kingston computer has been to establish the compatibility of the Bomarc weapon system with the SAGE system With its range of from 200 to 250 mi. the Bomarc IM-99A can provide effective intercept coverage of an area up to 500,000 sq. mi.

To study the problems of integrating the two systems International Business Machines Corp.'s Military Products Division set up under Air Force contract at its Kingston, N. Y., plant the essential elements of a SAGE direction center

The XD-2 computer used in the program basically is one half of the normally duplexed AN/FSQ-7 computer manufactured by IBM for SAGE direction centers

The computer receives radar data on target position from radars at Patrick AFB over leased telephone lines and uses this to compute track and interception point and generate a situation display for operating personnel When the weapons director presses the fire button, the computer directs the launching of the missile and continuously controls its flight to the interception point by radio data link until the missile begins its terminal dive when its active radar homing system takes over

The first firing under control from Kingston was on Aug. 7, and there have been nine launchings since One of these tests, on Oct. 21, involved the successful firing of two missiles 10 sec. apart from adjoining hangars against separate targets In a firing on Sept. 24

TWO Bomarc IM-99A missiles were successfully launched 10 sec. apart against separate targets under control of the IBM computer at Kingston, N. Y., on Oct. 21

a Bomarc destroyed a QX-10 drone traveling at 48,000 ft. at Mach 1.6.

Present production version of Bomarc IM-99A has an integral liquid propellant booster rocket made by Aerojet-General Corp. which uses a mixture of JP-4 and UDMH (unsymmetrical dimethyl hydrazine) as fuel and red fuming nitric acid as oxidizer. Burning time of the booster is about 45 sec. (AW Aug. 4, p. 62).

Sustainer powerplants for the IM-99A are paired Marquardt RJ43-MA-3 ramjets, 28 in. in diameter and weighing just under 500 lb.

Design speed is Mach 2.5 where the engines produce the equivalent of 50,000 hp.

The missiles are housed in launch station enclosures, one Bomarc per enclosure, in a horizontal position on their hydraulically operated launchers. This condition is termed "ready storage" because critical missile circuits are continuously and automatically checked on a 24-hr. basis.

When a missile battery is activated, the missiles are elevated to a vertical position and avionic equipment is energized. After a missile has been warmed up and checked out it goes from the warmup condition to standby until the "fire up" order is received from the SAGE direction center.

Operation of the integrated SAGE-Bomarc systems will follow the present procedures employed in the Kingston controlled firing tests. An AN/FPS-20 long range search radar located at Patrick AFB 15 mi. southwest of Cape Canaveral scans the missile test range and transmits range and azimuth data to the computer through a Burroughs Corp. AN/FST-2 coordinate data transmitter.

The computer stores the received information on a magnetic drum where it is read out by the computer program every five seconds. The program then calls for the computer to convert target position from polar to Cartesian coordinates relative to the missile launching site and compute the interception point and guidance information on a continuous basis.

The Cartesian coordinates of targets being tracked are transmitted to an AN/FPS-6 height finder radar and height of target is transmitted to the computer in the same manner as search radar data.

The tracking console of the computer displays the situation on a continuing basis, showing target tracks and displaying by means of "symbology" information as to whether the target has been identified as hostile, the merit of the radar track, and an identification number.

Simultaneously, the computer has automatically been preparing to fire. The readiness status of missiles under its control has been requested from the launching status multiplexer at the launching site. This information is displayed digitally at the weapons console. Missiles ready for firing are shown at the console to be in the "standby" status.

The weapons console operator requests an engagement prediction point from the computer for the target he wishes to attack. The computer relates target data and Bomarc flight characteristics and displays a small square on the situation display at the point where the missile would intercept the target if fired at that moment. A bracket appears around this point when the fire command is given, and the square is replaced by an "X" when the missile becomes airborne.

When the fire command is given by the weapons console operator, the missile goes to "fire up" status. During the few seconds required for ignition of the booster, the pre-launch computations of the computer are transmitted to guidance system of missile.

The Bomarc leaves the launcher in a vertical climb with the liquid propellant booster at full thrust and flares to ignite the ramjet engine already lit. Within a few seconds after lift off, the ramjets ignite and add their increasing thrust to that of the booster.

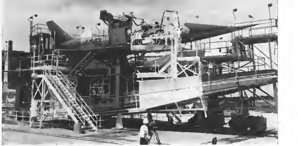
Initially, the missile climbs vertically then turns in the programmed direction and climbs at a relatively sharp angle in an inverted position. Stability during this phase is provided by the gimballed thrust chamber of the booster. The reason for inverted flight during the climb phase is that the missile is not roll-stabilized and for aerodynamic reasons assumes this attitude until leveloff at altitude when mid-course guidance takes over.

The IM-99A cruises during the mid-course phase towards the interception point under continuous control of the computer through its data link system at an altitude of about 70,000 ft. and a speed of about Mach 2.6. At a point figured by the computer, the missile noses over into a dive and its active homing radar is commanded to search in the direction of the approaching target. When these orders have been transmitted, the computer surrenders control of the missile to the homing system which then searches for the target, locks onto it and completes the intercept. Either conventional or nuclear warhead can be used.

A new version of the Bomarc, variously known as the Super Bomarc and the Bomarc B (IM-99B) is under active development and will fly early next year.

To provide facilities for testing the new missile, the original dimensions of the Eglin Gulf Test Range, now under construction, have been expanded by the Air Force from 100 x 300 mi. to 150 x 450 mi. (AW Nov. 10, p. 32). International Telephone and Telegraph Laboratories has received a contract from the Air Force for overall system design and implementation.

The range is scheduled to be operational in 1959 and completed in 1960. Presently being installed are tracking and instrumentation radars, telemetry equipment and optical tracking systems, drone tracking and control systems, data transmission equipment, countdown systems, and associated support equipment.



USAF North American Navaho cruise missile at Cape Canaveral is on mobile launcher built by Food Machinery and Chemical Co

Project RISE Utilizes Navaho in Firings

Eleven flights of XSM-64, with two 120,000 lb. thrust Curtiss-Wright ramjets, were made in Navaho and RISE programs. Five vehicles were left after RISE (Research in Supersonic Environment) was canceled. SM-64A would have carried a third ramjet. Booster, using three Rocketdyne engines, has produced more than 450,000 lb. thrust, still may be used in cluster for space projects. Navaho launches were preceded by 27 flights of X-10 jet-powered test vehicles. Last two of 13 X-10s are to be used as drone targets for Boeing Bomarc interceptor missile

ROTOR MASTS on Bell XV-3 convertiplane are in about 85 deg. position for full forward airplane flight configuration.

XV-3 Makes First Complete Conversion

Ft. Worth—First complete conversion of a fixed wing, tilting rotor convertiplane from helicopter to airplane flight was made here by the Bell Helicopter Corp XV-3

Experimental Bell convertiplane made its first conversion at 4,000 ft and reached an airspeed of 115 kt and the ship has flown for about five minutes in the airplane configuration Bell is developing the XV-3 for the Army under administration

Full conversion of the XV-3 was a major step in a research program designed to combine the hovering and vertical flight capability of the helicopter with the greater speed and range of the fixed wing aircraft Bell is proceeding with flight tests, and the aircraft will also go through a USAF test program

Bell says results from flight test and wind tunnel work prove out its convertiplane approach in the search for VTOL aircraft and vice president-engineering Bartram Kelley told AVIATION WEEK the company thinks it is on the right track and plans to continue He said Bell now has the know-how to design a turbine-powered rotor propeller aircraft for a specific mission

Comparing the Bell approach with tilt-wing techniques, Kelley pointed out that each involves rotorprop inefficiencies Rotorprops on tilt-wing aircraft are inefficient in hovering and cost a great deal of power to get the VTOL off the ground and into the airplane configuration, he said With the convertiplane, the rotorprops are efficient in hovering, but inefficient in forward flight This forward flight drawback can be ameliorated, however, by shifting gears to reduce rotorprop speed, and Kelley feels this capability gives the convertiplane an advantage over the tilt-wing VTOL

The XV-3 is powered by a 450 hp Pratt & Whitney R985 engine that delivers about 400 hp to the rotors The aircraft could use more power, but the R985 was chosen for reliability Lightly powered as it is, the XV-3 has flown carrying two men, although only the pilot was aboard during the initial full conversion flights The convertiplane has a normal gross weight of 4,700 lb and an empty weight of about 3,500 lb Maximum fuel load is 600 lb furnishing four hours flight duration

Control is accomplished by a system that automatically converts as the XV-3 converts between helicopter and airplane configuration Standard control techniques are used in each configuration Airplane control surfaces are linked to the system at all times, but as the XV-3 converts to forward flight, the system changes progressively so the three helicopter attitude controls are mechanically cut out and the pilot enters forward flight using his col-

XV-3 MASTS are in about midway point toward conversion; angle here is about 65 deg

Sud Aviation Develops Model 3200 Triple-Turbine Helicopter

Artist's conception of Sud Aviation's Model 3200 heavy helicopter shows large external fuel pods which also serve as main landing gear braces. Company is developing the triple-turbine helicopter to carry at least 20 persons under all weather conditions (AW Nov. 24, p 35) Engines are three Turbomeca Turmo 2 turbines producing 396 eshp each Intakes for first two are located in forward section of top cowling, screen at rear probably is intake for the third First flight is set for next month Sud and Republic Aviation Corp reportedly are discussing license rights for U S manufacture

lective pitch control solely as a propeller pitch control

Rotorprop system uses a highly twisted rotor in a two-bladed configuration with a diameter of 23 ft The original system had a three-bladed, articulated rotor that apparently could not meet the conditions imposed by flight testing and which was at the root of an accident with the original XV-3 that set the program back a year Current XV-3 is the second one built

Rotorprop system in the Bell aircraft presents some difficult problems since the rotorprops are mounted at the tip of each of the convertiplane's stubby wings The problem is to design a system that will work on a flexible wing under a variety of dynamic conditions, including high rpm in helicopter flight high rpm in converted flight and low rpm in converted flight So far, Bell has flight-tested the system in the first two configurations

The answer to the mechanical stability problem, which the original system failed to solve, grew out of some rotor studies Bell conducted on its own This program produced the underslung feathering axis hub that is used on the turbine-powered HU-1, and the same type of hub was adapted for the current XV-3 two-bladed system

Bell has also just completed a study for the Air Force on rotor propellers for VTOL aircraft, and this knowledge also contributes to company design efforts in the field Chief experimental engineer Robert Lichten said the system on the XV-3 has no basic speed limits other than general propeller speed limitations and that future designs based on it should be able to operate easily at 300 kt

Bell's technique for increasing efficiency of the XV-3 rotorprop in forward flight is to shift gears to cut rotorprop speed about 50%

The rotor is traveling too fast in the helicopter configuration to do well in forward flight and the speed reduction allows it to revolve more slowly and take a deeper bite Shifting is done in the main transmission with a clutch system It has been done a number of times in tunnel tests, but Bell has not tried it yet in flight testing Use of a free turbine powerplant with its inherent flexibility would greatly simplify the process involved in changing rotorprop speeds

Conversion of the XV-3 can be done at any rate, and Kelley said the convertiplane can be flown indefinitely in a steady state at any intermediate point in the conversion cycle He said there is no critical point in the cycle which must be hurried through

On a typical flight, the convertiplane will convert to 10-15 deg after takeoff and climb at about 50 kt Then conversion is advanced to 45 deg at 80 kt and speed increases to 110 kt as the conversion progresses to a full 90 deg In case of engine failure, power-off conversion back to helicopter configuration can be made for an autorotation landing Test pilot William F Quinlan took the XV-3 to 115 kt during his brief initial full forward flight

Top helicopter speed of the XV-3 is about 105 kt., and flaps have been added to the wings which reduce stalling speed in forward flight to about 85 kt This leaves an overlap of 20 kt as a safety margin

The convertiplane has been tested twice in an Ames Research Center wind tunnel Both the gear shifting operation and high speed performance were measured, and the aircraft was tested up to 154 kt with rotorprops shifted to lower speed It was tested up to 140 kt in the tunnel with rotorprops at the higher rpm., but the speed limit without shifting in flight test is 115 kt

In the Ames tunnel tests, Bell had pilots actually operating the XV-3 in the tunnel, shifting gears and going through other flight operations It was handled in the tunnel by Bell, NACA and USAF pilots

Total Sales of Over $410 Billion Predicted for Industry in 1958

By Ford Eastman

Washington—Total uninterrupted sales for the aviation industry probably will run "well over" $10 billion for 1959, the Aircraft Industries Assn. reports in its annual year-end review. Total 1958 sales are estimated at approximately $11.8 billion.

Anticipated decrease in military aircraft sales during the year, AIA says, may be offset by increased missile and space vehicle contracts coupled with deliveries and new orders for turbine-powered commercial transports and a continuing high market for business and utility aircraft.

Pointing out that an exact forecast of the 1959 level of activity in the aircraft industry is not possible since it is geared to Defense Department expenditure policies, AIA President Orval R. Cook said that barring a national emergency combined expenditures for military aircraft and missiles in 1959 should remain at approximately the 1958 level.

Research and development expenditures will increase, Cook said, and a larger percentage of the aircraft industry contracts will be for research and development. This trend, however, may seriously affect the rate of earnings of the industry as more emphasis is placed on research and development, less on lengthy production runs.

Despite this, Cook said the Defense Department is continuing its policy of reduced progress payments and of requiring larger investments by companies holding cost-plus-fixed-fee contracts.

Employment in the industry continued to decrease during the first five months of 1958 but it has increased slightly since then. In May, after 13 consecutive months of decline, industry employment had dropped to 742,800, the lowest since 1955. By September the total had climbed to 760,900.

Scientific and technological progress, Cook pointed out, is resulting in radical organizational changes among aircraft companies. To meet the changing needs, companies traditionally associated with air frames only have now become leaders in propulsion, guidance systems and atomic energy applications, the report said.

Cook said virtually every company in the industry is active in one part of the guided missile program or another, holding about 80% of the prime contracts for the major missile components.

Financial Breakdown

Detailed breakdown in the report included:

- **Production of military aircraft** declined from an estimated 5,500 units in 1957 to about 4,000 units in 1958. This was partially offset by rising expenditures for missiles and space vehicles.
- **Value of commercial sales of aircraft,** engines, propellers and parts in 1958 was estimated at $1.5 billion as compared with $1.6 billion in 1957. Commercial sales for the first three quarters declined as piston powered aircraft were being phased out of production. This decline was partially offset as the first turbine-powered airline transports were delivered and an increase in sales was estimated for the fourth quarter.
- **Commercial aircraft production,** including helicopters, for 1958 is estimated at 6,780 units, slightly higher than the 1957 output of 6,745 units, although the value is estimated at about the same. A total of 225 transports including 50 turbine-powered aircraft were delivered in 1958 as compared with 322 in 1957. At the end of October, U.S. manufacturers had orders for more than 600 turbine transports valued at about $3 billion.
- **Utility aircraft production** increased in 1958. About 6,300 utility airplanes were delivered during the year as compared with 6,118 in 1957. The value was estimated at $100 million, about the same as last year.
- **Ratio of earnings to sales** for the first three quarters of the year was about 2%—4% below the similar 1957 period. Fourth period results are not expected to improve the annual ratio.

Twelve Bids Submitted For Capsule Contract

Washington—Twelve bids have been submitted to the National Aeronautics and Space Administration for development of a manned orbital capsule. Thirty-eight firms were originally briefed on the project in November (AW Nov. 17, p. 27).

Companies that elected to bid on the capsule and play an important role in NASA's man-in-space program, Project Mercury, are:

- **Grumman Aircraft Engineering Corp.**
- **Chance-Vought Aircraft**
- **North American Aviation**-General Electric Co. bidding as a team
- **Convair Division of General Dynamics Corp.**
- **McDonnell Aircraft Corp.**
- **Northrop Aircraft**
- **Avco Manufacturing Corp.**
- **Martin Co.** (Denver)-Radio Corporation of America
- **Republic Aviation Corp.**
- **Lockheed Aircraft Corp.**
- **Douglas Aircraft Corp.**
- **Winzen Laboratories**

U.S. to Order Fiat G.91s for NATO

Paris—United States plans to order 50 Fiat G.91 lightweight strike fighters for deployment with NATO forces.

The U.S. decision was made in consideration of the orders placed by other countries. U.S. officials would not state which NATO allies would get the aircraft, though Turkey is a likely candidate.

The Fiat fighter was selected as NATO's first generation lightweight fighter after competition between it and two French fighters, the Breguet 1001 and Dassault's Etendard 6. All three aircraft are powered by Bristol's Orpheus turbojet engines.

It was understood the U.S. order was made after assurances that West Germany and Italy would order at least 50 each. Germany recently indicated it had earmarked $187.5 million for purchase of 200 G.91s, of which 50 will be ordered directly from Fiat and the balance built in Germany. The Italian government to date has ordered only 20 trainer versions and 20 reconnaissance versions but presumably will order at least 50 of the NATO tactical fighter version.

No other NATO government has placed orders for the G.91.

The idea behind the lightweight fighter competition was that once a standard fighter was decided upon, NATO nations all would order the aircraft and share in its manufacture. It wasn't expected the U.S. would order any production versions of the G.91. Originally Mutual Weapons Development Team funds were used for the ordering of about 30 preproduction G.91s which are to be used in evaluation work.

Chemical May Permit Gyro Miniaturization

New York—Development of a new halocarbon chemical, bromotrifluoroethylene oil, promises to have a significant impact on the miniaturization and logistics of inertial guidance systems now under development for the Lockheed Polaris missile and North American X-15 research vehicle.

An outgrowth of the chlorotrifluoroethylene polymers which already have found wide application as inert lubricants and damping fluids in the missile field, bromotrifluoroethylene will be used to float the gyros and accelerometer in the X-15 inertial system developed by Air Armament Division of Sperry Gyroscope Co. The chemical, developed by Halocarbon Products, Corp., probably will be used as the damping fluid in the Polaris inertial system under development at Massachusetts Institute of Technology as well as in other systems.

Sperry's principal interest in the new fluid stems from its low temperature plasticity. Until now, gyros and accelerometers had to be kept heated and spinning to prevent them from freezing prior to flight. If units using the older chlorotrifluoroethylene fluids were stored at low temperatures, the damping fluids would return to a wax-like consistency and shrink. Fissures generally developed in the wax; when these fissures or cracks fell across thin lead-in wires which conduct power to the gyro wheel, the wires would break.

On the other hand, the bromotrifluoroethylene fluid can be stored at temperatures as low as −65F according to Sperry, thereby eliminating the need to keep the gyros heated and spinning prior to use. Upon heating, the material quickly comes to design temperature because it melts much faster than the straight chlorotrifluoroethylene fluid.

First Titan Attempt Fails at Canaveral

Cape Canaveral, Fla.—First attempt to test launch an Air Force-Martin Titan intercontinental missile failed Dec. 20 but automatic cutoff of the engine saved the vehicle.

Shot was to have been for no more than 300 mi. to test functioning of ground support equipment, launching sequence and controls, safety system, telemetry and first stage propulsion. Second stage carried ballast, including 5,000 lb. of water, and no engine. No separation was planned and no vernier engines were attached.

Two-barreled first-stage Aerojet engine is designed to produce some 300,000 lb. thrust. Second-stage Aerojet engine, to be ignited in the air, is to produce about 60,000 lb. Titan is of rigid construction, requiring no pressurization for strength. First stage has 10-ft. diameter, second is eight ft.; overall length is about 90 ft. Separation is achieved by explosive bolts and primer cord weld.

Missile is held for five-six sec. after ignition by a ring in case thrust decays early or other forms of malfunction occur.

Cancellations Cripple Chance Vought

Dallas—Navy cancellation of the Chance Vought F8U-3 interceptor and the Regulus II missile system within a one-week period resulted in the immediate layoff of 3,500 employes and a cut in anticipated company business by an estimated $75-$80 million.

Cancellation of the turbojet-powered, 1,000-mi.-range Regulus II also left Navy with a problem—two submarines equipped to carry the missile and only a total of 70 on hand.

Once these are expended, the two submarines—the conventional Grayback and an atomic powered vessel soon to be commissioned—will be converted to use the 500-mi.-range Regulus I or another type missile. Regulus I production also has been cut off, leaving Navy with approximately 250 in its inventory.

Decision to terminate the Regulus II, predicted by Aviation Week on Dec. 8 (p. 25), was attributed by the Defense Department to the need to "provide the best balance in over-all Navy weapons systems within the resources available at present and for the foreseeable future." Navy officials, however, were clearly disappointed by the cancellation, and Chance Vought President Fred O. Detweiler said flatly that "Defense Department economy measures dictated its termination despite Navy measures to maintain it."

The Navy, Detweiler added, "regretted the timing of these cancellations, with their resulting personal hardships, as much as I."

Termination of the F8U-3 was ordered after the McDonnell F4H-1 was named winner of Navy's flight test competition for a new carrier-based all-weather fighter (AW Dec. 22, p. 22).

The cancellations left Chance Vought with a backlog of $350 million and, with production orders on hand for the F8U-1, F8U-1P and F8U-2, won't materially affect the company's financial position in either 1958 or 1959. "It's the years after that which are really affected," Detweiler explained, "and new business will have to be found to replace the F8U-3 and Regulus II programs."

The company reported a net income of $7,235,892 for the first nine months of this year, equal to $6.18 per share and approximately double the 1957 figures. Sales for the 1958 period totaled $249,927,097.

In an effort to cushion the blow of its losses, Chance Vought already has teams in the fields looking for new business from industry prime contractors and, according to Detweiler, has secured orders to manufacture assemblies "for a new jet transport." The company also is designing the pilot compartment in Boeing Airplane Co.'s bid for a contract to produce the Dyna-Soar orbital bomber. It also has invested a large amount of its own capital in the development of tactical missiles in hopes of obtaining Army contracts and plans to double its investment in research and development facilities in 1959 over 1958.

News Digest

Watch for the Pratt & Whitney J112 turbojet to replace the General Electric J85 in the production version of the North American T-39 twin jet Rainer. Air Force has ordered the T-39 into production and is expected to make a formal announcement on the engine switch shortly.

Kaman Aircraft Corp. is seeking registration of an offering of $1,250,000 in convertible subordinated debentures, the proceeds to be added to working capital. Interest rate will be 6% and the conversion price probably in the lower $20 a share range, compared with a current market price of $15-17 a share. Analysts consider terms a high price for capital but not unexpected in view of the aircraft financing situation.

Boards of Directors of Aeronca Manufacturing Corp. and Longren Aircraft Co. have approved a formal merger agreement. Contract has been signed, subject to approval of shareholders of both companies.

Hawker Siddeley is developing a new VTOL fighter in which both the British and American governments are interested. Expectations are for "a close support fighter with vertical takeoff capacity which will do all that the Hunter can do." It would be powered by, according to Sir Roy Dobson, Hawker Siddeley managing director, a special engine being developed by Bristol Aero-Engines with U.S. financial help. Hawker Siddeley is also developing a flying jeep that is called the Aerocar in Canada.

Fairchild Aircraft and Missiles Division has received an $11 million follow-on contract for production of components for Boeing's B-52G intercontinental bomber.

'Fourth' Crewman Fails to Halt Strike

American charges 'bald-faced featherbedding' after pilots renew other jet demands.

By Glenn Garrison

New York—Agreement by American Airlines to use a third pilot in its jets failed to forestall a strike by its pilots, who walked out Dec. 19 after demanding terms the airline calls "bald-faced featherbedding."

Sharp criticism of the pilots six-man negotiating committee by American's President C. R. Smith included charges that it was weighted with relatively junior pilots with little representation from the airline's senior pilot group. Smith also charged that the committee never intended to negotiate "in the usual way," but planned to get all it asked for or to call a strike.

"We are also of the impression," Smith wrote the airline's employes, "that the strike was intended, planned and called, even at an early stage of the negotiations."

Day-and-night negotiations in the dispute had continued almost up to the midnight strike deadline. According to the airline, settlement appeared to be in sight when the pilots walked in with a last-minute list of renewed demands to which "no responsible airline could agree." American then broke off the negotiations.

Basis for agreement on the crewman issue is employment of a third pilot in addition to the flight engineer, Air Line Pilots Assn. told Aviation Week. American will not confirm or deny this, but acknowledges a compromise had been agreed upon in the issue. Third crewman point did not actually get onto the bargaining table, however, because the other issues were considered first and were unresolved.

According to ALPA, the fourth man solution was proposed by the airline.

The pilot union says issues causing the breakdown primarily involved working conditions, and a major point was pay and credit for non-flying duty time and time away from home. The pilots asked one hour of full flight pay and flight credit for every three hours of non-flying time on duty, for time away from home but not on duty they asked one hour's pay and credit in every four hours.

The pilots also demanded a reduction in their work month on jets from 85 hr. to 75 hr. Wage dispute between the union and the company, ALPA said, finally involved only minor differences.

American offered the pilots about $28,000 a year for captains and $17,500 a year for jet copilots. The airline says the union rejected the wage scales as insufficient and unacceptable.

But if the work month was shortened to 75 hr. the pilots would accept $27,500, the airline said. This would represent compensation under the present 85 hr. setup at the rate of $31,176 a year, American pointed out.

In his letter to American employes, Smith said most members of the pilots' negotiating committee were relatively junior men and appeared most willing to talk about provisions and benefits which would most directly affect junior pilots.

"During the course of these recent negotiations, if they can reasonably be called negotiations," Smith wrote, "we had to spend a high percentage of the time talking about benefits for reserve pilots. This is, of course, an important subject, but the emphasis on it may have come from the fact that many of the committee members are reserve men."

Mediation Proposals

New York—American Airlines last week accepted proposals made by the National Mediation Board in an effort to reach agreement with the airline's pilots and end a strike which has shut down operations. ALPA made no immediate decision.

The Board telegraphed the airline and the union after giving "serious consideration to the inconvenience to the travel ing public at the holiday season . . . ." It asked immediate replies as to acceptance or rejection of its proposals "in toto and without equivocation."

Acceptance by both parties would mean immediate resumption of service without prejudice to the right of either. American President C. R. Smith said the Board's recommended settlement represented a compromise between the viewpoints of the two parties, but "it is an acceptable compromise and we have agreed to it." Net effect Smith said would be to establish the industry's highest rates of pay for domestic airline pilots.

ALPA's comment on the committee's makeup is that the group is elected by pilots in American Airlines' chapter of the union.

Smith told his employes that ALPA ". . . has chosen Christmas week as a suitable time for a strike. It has done this because it has become selfish and arrogant. It has done this in order to say to us and to you, 'we want what we want when we want it . . .' (ALPA) cares little for public opinion . . . it seems willing to bring discredit on other good union men. It believes that by forcing hardship upon others it can require acceptance of even the most unreasonable of its demands."

Regarding the eleventh-hour negotiations, Smith said, "14 min. before the strike deadline in Chicago, while discussions were still going on, but after the pilots had gone on strike in New York, the committee came back with a long list of renewed demands including shorter hours, more money than we had previously discussed and a renewal of the featherbedding rules.

"It became apparent, to all, that the committee did not want to reach an agreement unless we would buy the demands of the committee with a blank check. The committee adopted this method, of renewed demands, to break off the meeting and the strike went forward."

In a statement issued immediately after the strike began, Smith referred to the pilots' demands as "ultimatums" and "unjustified," and said there was no good reason for a reduction in hours. Some of the carrier's pilots now are flying 10 days a month with 20 days a month off, Smith said, "and it would be difficult to improve these working conditions. . . . If the airline wants to inherit the economic problems of the railroads, agreement with the featherbedding requests of the pilots association is apt to bring that about."

ALPA told Aviation Week it didn't feel it was "featherbedding" to seek payment for "excessive on-duty time." ALPA has charged that shortcomings in working conditions are aggravated by "failure of the company to provide relief from problems resulting from unrealistic schedules."

The spokesman said ALPA has "at least six major contracts" which provide ratios of pay and credit for non-flying time on duty and time away from home.

The airline has retained its more than 20,000 employes other than striking pilots at full pay through the holidays, to be followed by emergency leaves after Jan. 4 without pay. Employes will continue to accrue full credit toward seniority, sick leave and vacations. Airline also will temporarily advance group insurance contributions for up to 90 days.

American last week was running full-page newspaper ads in 14 of its key cities, with headlines citing "Let Others Be Damned" as ALPA's attitude in the Christmas strike. Airline and most of its employes, the ads apologize, are "disappointed and ashamed" that holiday commitments can't be made good.

In another strike, holiday travelers were still denied the services of Eastern Air Lines, closed down by mechanics' and engineers' strikes which began Nov. 24.

Agreement has been reached between Eastern and its mechanics, but no announcement from International Assn. of Machinists is expected until the engineer dispute is resolved. A mediator was talking separately with Eastern and its engineers last week, but no definite progress was reported. Flight centers on Eastern's decision to require pilot training of its engineers.

Flight engineers' acceptance of a loan from James Hoffa's teamsters' union was followed by Miami reports that Eastern pilots might refuse to fly with engineers if they tied up with Hoffa.

George Sheridan, Eastern captain who is chairman of ALPA's council in the airline, told Aviation Week that pilots could not accept the Hoffa element and meet their responsibilities to the public. Sheridan said the pilots would refuse to fly with the flight engineers if there were one act of violence as a result of the engineers' association with Hoffa's union.

The Eastern pilot said he had received a number of anonymous, threatening phone calls, and other pilots also had been threatened. The flight engineers, however, vigorously denied such threats had been made and described the pilot reports as unsupported allegations.

Hong Kong Merger

Hong Kong—Cathay Pacific Airways and Hong Kong Airways have merged to create the largest regional carrier in the Far East. Observers here say merger plans embrace an expansion program that will extend routes of the newly-formed airline to serve all major areas throughout the Far East.

At present, Cathay operates 7,746 route miles with a fleet of DC-4s, DC-6s and DC-6Bs. The company has two Lockheed Electras on order. Hong Kong serves 3,459 route miles with Vickers Viscount 760s.

Lines Report Record Revenues

By Robert H. Cook

Washington—Record revenues of $1.5 billion earned by the domestic trunk carriers in 1958 failed to turn the tide of sinking profits as the industry fought ever increasing expense levels and a dwindling traffic growth.

Year-end figures compiled by the Air Transport Assn. show that, while trunk line revenues were up 7.4% over 1957, reflecting three times the amount of business realized in 1950, the nation's 12 major carriers netted only $30 million in 1958. A $3 million gain over last year, the figure is only half that recorded in 1956 and approximates the domestic trunk net of 1950.

At the same time operating expenses rose at a nearly equal rate from $1.3 billion for the entire industry last year to a record high of $1.4 billion this year.

Viewed from a point of profit margin, the financial progress of domestic airlines showed an almost negligible improvement over the 1.9% of 1957, according to ATA. For, although the earnings per dollar of sales were up one tenth of a cent from last year, the profit margin was five cents below that of 1952 when the carriers had a net profit of more than $53 million.

Traffic growth, as measured by revenue passenger miles, was at a virtual standstill this year as compared to the past gains of 13 to 18% annually, the ATA reported. For the entire scheduled industry, revenue passenger miles increased by only 1.8% as compared to last year, while the total for the domestic trunks alone was only 1% above that of last year.

Nearly half of the traffic increase of the total scheduled industry was experienced by the local-service carriers who recorded a 7% gain in revenue passenger miles.

International and overseas airlines reported a 4.7% traffic gain.

Greatest single expense for the airlines are wages and employe benefits which account for nearly half of trunk-line operating expenses, ATA reports. Total payroll of the U. S. scheduled industry, employing an estimated 150,000 people, reached $827.4 million for the year ending March 31.

In an estimated tabulation of traffic by classes of carriers the ATA recorded the following:

- **Total domestic**—Flew 25.5 billion passenger miles for a gain of 1.1%. Mail ton-miles up 6.5% to 105.2 million. Express ton-mileage of 47.3 million, up 6.7%, freight ton-mileage of 234.6 million, up 6.4%. Revenue ton-miles were 2.8 billion for a 1.7% increase.
- **Domestic trunks**—Passenger miles climbed 1% to 24.7 billion. Mail ton-miles were 103.5 million, up 6.4%. Express ton-miles rose 6.7% to 45.6 million, freight increased 6.4% to 232.5 million ton-miles. Revenue ton-miles totaled 2.8 billion, up 1.5%.
- **Local service**—Passenger miles totaled 799.5 million for an increase of 7%. Mail increased 7.8% to 1.6 million ton-miles.
- **Express volume went up 5.7% to 1.7 million ton-miles**, air freight rose 2.3% to 2.1 million ton-miles. Total revenue ton-miles amounted to 84 million, up 7.1%.
- **Helicopter**—Three scheduled helicopter airlines in New York, Chicago and Los Angeles flew 4.9 million passenger miles for an increase of 51% over last year. Mail dropped 6% to 85,000 ton-miles. Express rose 17.4% to 40,000 ton-miles, and air freight dropped 36.4% to 9,000 ton-miles. Total revenue ton-miles amounted to 600,000 for an estimated gain of 35%.
- **All cargo lines**—Slick Airways' discontinuance of service in the early part of the year resulted in a sharp reduction in over-all volume figures for this group. Accordingly, the all-cargo carriers showed a 40.2% drop in mail, a 56.2% drop in express and 31% decrease in freight. They carried a total of 1.1 million ton-miles of mail, 700,000 ton-miles of express and 107 million ton-miles of air freight. Total revenue ton-miles declined 11.3% to a figure of 298.7 million.
- **U. S. international**—Passenger miles climbed 4.9% to six billion. Mail ton-miles up 10.8% to 63.4 million. Cargo rose 4.7% to 129.1 million ton-miles, and total revenue ton-miles up 6.1% to 907 million.
- **Alaska**—Passenger miles totaling 157.1 million were up 3.4%. Mail ton-miles increased 13.1% to 3.1 million, with cargo totaling 6.1 million ton-miles—a decrease of 15.4%. Total revenue ton-miles for the Alaska group were thus down 10.4% to 29.4 million.
- **Territorial**—Passenger miles decreased 8.8% to 81.6 million. Mail volume increased 23.1% to 80,000 ton-miles and cargo increased 6% to 1.6 million ton-miles. Revenue ton-miles for this group totaled 11.3 million for a total gain of 25.7%.
- **Total international and overseas**—U. S. international operations, along with Alaskan and territorial scheduled airlines, accounted for 6.3 billion passenger miles or 4.7% more than was recorded for the group last year. Mail volume of 66.6 million ton-miles was up about 11%, cargo increased 3.6% to 136.8 million ton-miles. Total revenue ton-miles for the combined groups increased 5.7% to 947.7 million.

Japan Plans Round-the-World Service

By L. L. Doty

Tokyo—Ambitious plans of Japan Air Lines to inaugurate an around-the-world scheduled all jet service within the next four years are drawing strong support from both the Japanese government and opposition parties.

Such united backing behind commercial aviation is in sharp contrast to the wide breech between two factions within the Japanese Diet on the subject of military aviation. The government of Prime Minister Kishi is campaigning hard for the manufacture of all-weather jet fighters in Japan to power the country's Air Self Defense Force in direct opposition to the Socialist-Democratic party which wants to erase all traces of militarism from Japan.

Growing Prestige

However, the fact that Japan Air Lines can bolster Japan's hard currency position is lending growing international prestige to the country and provides the nation with an essential domestic transportation system leaves the opposing parties with no other choice than to agree on the subject of commercial aviation. It is one of the few subjects on which the two major political parties see eye-to-eye.

Consequently the international carrier is virtually assured of any political or financial backing it will need to launch its wide scale program. And since its current order for four Douglas DC-8 jet transports represents only a part of its over-all re-equipment plans to back its global service Japan Air Lines is drawing serious attention from aircraft manufacturers throughout the world.

Their task will be somewhat simpler than the job facing officials of Lockheed and Grumman, two major competitors in the race to sell jet fighter assembly rights to Japan. Before the Diet decides whether the Grumman F11F-1 or the Lockheed F-104C, or possibly some other fighter, will be Japan's choice, it must first agree that it wants a jet fighter of any type. It must then appropriate the money to place the order. Finally, it must seek funds to underwrite a pilot training program since Japan is now virtually without any qualified jet pilots.

On the other hand the decision as to which type jet transport will be purchased to supplement the DC-8s will be made by Japan Air Lines—not the government. Budget covering the airline's expansion plans has been submitted to the government and should win the Diet's approval without any political wrangles blocking the way.

Severe shortage of pilots for commercial purposes exists but a pilot training program is under way. The program is not yet satisfactorily filling the airline's entire needs—35 of the company's 150 pilots are Americans—but the carrier is making some headway toward its goal of manning its projected fleet with all-Japanese crews.

Japanese government has a 70% participation in the company's capital structure. However, the airline is operated as a free enterprise and has required no government subsidy during the past two years. Its Pacific route began showing a consistent profit 16 months after the service began in February, 1953.

Future Program

Seijiro Yanagita, president of Japan Air Lines, told Aviation Week that its around-the-world service will begin in 1963 with the four DC-8s Douglas is scheduled to begin delivering in May, 1960. Here is the program designed to lead to the around-the-world operation:

- **Tokyo-London route** via the North Pole will be opened in 1961 with the DC-8s. At the same time, the airline will open a southern route between the two cities via Calcutta, Karachi, Beirut, Rome and Paris. Japan Air Lines will purchase a fleet of medium-range jets to cover the latter service.
- **Tokyo-Seattle jet transport service** with DC-8s also will be inaugurated in 1961. Medium range turbojets will be purchased to serve the Tokyo-Manila-Djakarta route in the same year.
- **Tokyo-Seattle route** will be extended to New York in 1962 with DC-8s operating over the entire route. Final link in the global system will be completed in 1963 with the introduction of DC-8 service between New York and London.

At present the airline is operating DC-7Cs and DC-6Bs on its international routes. A fleet of 10 DC-4s handles the domestic system.

Average monthly utilization of the airline's four DC-7Cs is 204 hr. 24 min. Utilization of the five DC-6Bs averages 219 hr. 54 min. Both the DC-7Cs and DC-6Bs are operated over the company's Tokyo-Honolulu-San Francisco route. Early next year JAL plans to start its new service to Los Angeles from Tokyo in accordance with the agreement reached with the U. S. on amendments to the bilateral air transport pact between the two countries (AW Nov. 24, p. 45).

Tokyo-Okinawa-Hong Kong and Tokyo-Hong Kong-Singapore runs are served by DC-6Bs. The aircraft also will be used on the Tokyo-Taipei-Hong Kong route when it is opened next year.

Japan Air Lines plans to convert its South American nonscheduled service next year to a monthly scheduled service. The route operates to Sao Paulo via San Francisco, New Orleans, Caracas, Belem and Rio de Janeiro. Behind the international expansion program lies an urgent need to obtain a greater participation in international traffic as a major factor in the development of the Japanese economy. According to Seijiro Yanagita, Japan's current share in world trade is 3.55%, whereas the airline's present share in the world's international civil air transportation is only 1.06%.

He adds that, although these figures imply a need to triple present schedules, Japan's operational pattern should be increased seven times in order to keep pace with anticipated traffic growth throughout the world. When the present expansion program has fully materialized by 1963, "JAL will be operating approximately five times as big as the present scale," Yanagita says.

On international services, Japan Air Lines carried 72,277 passengers during the 12-month period ending Sept. 30. The carrier flew 185 million passenger miles, 3.9 million cargo ton miles and 2.5 million mail ton miles.

Domestically, the airline carried 399,155 passengers a total of 175 million passenger miles during the same 12-month period. Cargo ton miles totaled 853,000 and mail ton miles amounted to 397,939 on the carrier's domestic routes.

Low Fare Advocate

A rigorous campaign is being conducted for lower fares on domestic routes as a first step toward increasing traffic volume within Japan. A similar policy embraces the company's international operations, and JAL probably will take the lead in introducing promotional types of discount fares on its Pacific routes. Although the company is making no official commitments on the controversial jet surcharge issue (AW Oct. 27, p. 26), most sources here feel the company will strongly oppose any such fare differential on major international routes.

The airline is now petitioning the government for elimination of the present 10% transportation tax. Such a move, coupled with a further reduction of fares, will place the company in a more favorable competitive position in relation to surface transportation facilities, Yanagita believes.

Eventually, Japan hopes to replace its DC-4s on domestic routes with the DC-6Bs now in international service and with short-range turbojet aircraft. The company is not giving serious consideration to turboprop models, but the possibility of placing an order for the British Fairey Rotodyne VTOL for local short haul operations is strong. Initially, turbojet aircraft will be introduced on the Tokyo-Osaka and Tokyo-Fukuoka and Sapporo routes.

JAL has completed a new maintenance hangar at Tokyo airport and now handles its own maintenance and overhaul functions, originally performed by United Air Lines at San Francisco under contract. Originally, Northwest Airlines furnished flight crews and other technical services including a pilot training program for Japanese fliers. Certain phases were subcontracted by Northwest to Transocean Air Lines.

Japan Air Lines became operational in 1953 when it took over Japanese Air Lines Co. following ratification of the peace treaty and the signing of a bilateral air transport agreement with the U. S.

Transpacific services began in February, 1954, with U. S. flight crews and two converted DC-6Bs purchased from Flying Tiger Line and one DC-6A from Slick Airways. Initial service of one weekly flight has been expanded during the past four years to daily round trip flights, five of which are operated with DC-7Cs and two with DC-6Bs.

Charge Delay

Charges that Japan Air Lines is delaying expansion of Tokyo Airport until 1960 when it is due to receive its DC-8 turbojet transports is contradicted by the company's petition to the government for prompt action on extending the field's main runway. An 8,400 ft. runway must be increased in length to 10,000 ft. before the airport can accommodate intercontinental turbojets.

Since such an extension will require filling in a portion of Tokyo Bay, the proposal has drawn bitter protests from fishing interests in Tokyo. Five fishing unions are claiming that compensation offered fishermen in the area by the government for surrendering fishing rights in waters which will be filled in or restricted by the runway expansion is not sufficient. Firm stand taken by the fisheries is the only stumbling block in the way of an airport improvement program.

Fiji Island Airport Readied for Jet Age

Main runway at Nadi International Airport, Fiji Islands, is being extended 4,000 ft. past its present 7,700 ft. length. Runway lies parallel to the coastline. The construction move is in preparation for jet passenger service by Pan American World Airways and British Overseas Airways Corp. Other work includes construction of a new terminal building and freight facilities. The airport services the capitol city of Suva.

Convair 880 Cabin Equipped With Test Instruments

Cabin area of first Convair 880 is occupied by ballast tanks and flight test instrumentation, transport will undergo evaluation in next few weeks, including structural and vibration testing. Aircraft rolled out two weeks ahead of schedule (AW Dec. 22, p. 34).

Controller Experiment

Washington—Civil Aeronautics Administration will revise its air traffic controller entrance requirements on an experimental basis to determine whether previous aviation experience should be a criteria for college educated candidates. Approximately 400 persons who are college graduates but who do not meet qualifications for controllers will be sent to CAA's Aeronautical Training Center beginning Jan. 1 to take the six-week course.

Vanguard Turboprop Set for First Flight

By John Tunstall

VANGUARD utilizes de Havilland propellers on its four Rolls-Royce Tyne engines. Scoop on outboard nacelle ducts ram air into heat exchanger for leading edge anti icing.

London—Vickers Vanguard turboprop transport, which was rolled out recently at Vickers-Armstrongs (Aircraft) Ltd. plant at Weybridge, England (AW Dec. 15, p. 39), is ready for its first flight.

Four other aircraft, in various stages of completion, using fully developed, duplicated producing jigging and tooling, are due to fly by September, 1959.

All five aircraft will be used in the certification program. Full certification is expected by March, 1960, when delivery to British European Airways commences.

Forty Vanguards have been ordered, 20 each by BEA and Trans-Canada Airlines. Deliveries to TCA are due to start in autumn, 1960. Production is set to reach three aircraft per month by 1961.

The Vanguard has been on engine runs and system checks in preparation for its maiden flight. During preflight tests, each of its Rolls-Royce Tyne-twin-spool, coaxial shaft engines developed 4,500 eshp., giving a total of 19,940 total equivalent horse power at takeoff.

The Tyne engine uses air cooled turbine blades to exploit high gas temperatures and a high pressure ratio of 13:1. These two features have enabled the new Rolls-Royce engine to check in with the unusually low specific weight of 0.42 lb./tehp. and a specific fuel consumption of 0.4 lb./tehp./hr. A slightly uprated version for aircraft delivered after 1960 will deliver 5,525 tehp. and have a fuel consumption of 0.39 lb./tehp./hr. This economy is comparable with the Wright Turbo Compound piston engine which has over twice the specific weight of the Tyne.

Vickers Vanguard Specifications

Dimensions	
Wing span	118 ft.
Fuselage length	122 ft., 10.4 in.
Height	35 ft.
Gross wing area	1,529 sq. ft.
Cabin interior width (maximum)	10 ft. 9 in.
Wheel track	30 ft., 2.82 in.
Weights	
Maximum takeoff weight	141,000 lb.
Maximum landing weight	121,00 lb.
Maximum zero-fuel weight	112,500 lb.
Capacities	
Current maximum payload as limited by zero fuel weight	29,000 lb.
Passenger seating capacity (first class)	76
Passenger seating capacity (mixed class)	36 first, plus 50 tourist
Passenger seating capacity (European tourist)	97
Passenger seating capacity (coach)	up to 112 or 139 (thrift)
Fuel capacity	6,120 U.S. gal.
Total cabin volume	5,890 cu. ft.
Freight hold volume	1,360 cu. ft.
Performance	
Cruising speed at maximum landing weight	425 mph. increasing progressively to 450 mph. between 1959 and 1963

Design Details

Although over twice the size, the Vanguard, at 141,000 lb. all-up weight, incorporates many design and engineering details proven on the Viscount which has now logged three million hours.

The Vanguard has a similar modified NACA 63 series wing section. It operates with the same cabin pressure differential, has the same fundamental systems and similar manually operated engine and flying controls.

Principal departures occur in the wing structure which now incorporates a twin torsion box with integrally machined skin stringer panels, and in the fuselage, which has a double bubble section.

Vickers describes the Vanguard as being the only second generation turboprop aircraft. Vickers feels the Lockheed Electra is more a late reply to the Viscount than as a contemporary of the Vanguard.

Structural Tests

Availability of Viscount data reflects on Vickers structural test program for Vanguard. This program is considerably less destructive than that instituted by other British manufacturers, and the company does not intend to carry out water tank fatigue tests on a complete production aircraft.

Viscount experience has also induced Vickers to stake its basic design philosophy on lower stress levels and the provision of alternative load paths. A few extra pounds of structural weight properly applied, Vickers designers believe, is more than compensated by reduced maintenance and overhaul costs.

The standard Vanguard now offered with the uprated Tyne engine cruises at over 420 mph. over most of its altitude regime. Maximum takeoff weight is 141,000 lb. and it can carry its maximum design payload of 29,000 lb. over a useful range of 2,000 mi., with substantial reserves (one hour at 5,000 ft. and a 230 mi. diversion). Seating provides for 139 economy passengers with a six abreast, 34 in. pitch layout, or 97 tourist class passengers.

Vanguard can lift its maximum takeoff weight from a 2,000 yd. runway under standard conditions. Its stalling speed (flaps down at maximum landing weight) is 98 kt.

Vanguard's unconventional feature is an under-floor freight hold in the lower fuselage bubble of 1,360 cu. ft. capacity which Vickers claims has seven times the earning capacity of its nearest competitor. The bubble, which represents a structural weight penalty of 1,000 lb. and a speed reduction of 4 mph., can accept almost 50% of Vanguard's maximum payload at normal densities (10 lb. per cu. ft.).

Operating Costs

Virtual absence of cost variations over wide cruising altitude band is one of the principal advantages claimed for the Vanguard propulsion system. This characteristic coupled with the Tyne's low specific fuel consumption is largely responsible for the achievement of seat mile direct operating costs below one cent for stages between 800 and 2,000 mi. using the economy class seating layout. These statistics from the companies cost curves based on Air Transport Assn. formulas show that the aircraft can be scheduled on stage lengths as low as 100 mi. for less than 2 cents per seat mile. This cost formula allows for a 65% passenger load factor, 10% profit margin, and takes no account of mail or freight revenue. For the 65% load factor there is still accommodation for 10,000 lb. of freight.

A Vickers survey shows that reductions of coach domestic fares on 20 typical routes, averaging 22%, would be possible with the Vanguard.

According to Vickers sales manager R. C. Handasyde, nothing has developed since the Vanguard design was set to qualify the confidence in Vicker's turboprop decision for short to medium stages on the grounds of its speed and height flexibility and propulsion economy. "With Rolls-Royce experience with both jet prop and pure jet engines, and Vickers jet bomber aircraft experience," said Handasyde, "we would have been happy to have made either."

Fairchild-Fokker F-27 Production Lines

Five Fairchild F-27 turboprop transports are in various stages of construction in this view (above) of Fairchild Engine & Airplane Corp. plant at Hagerstown, Md. Aircraft in foreground is nearly ready for rollout; succeeding airplanes in the production line await engine and wing installation. F-27 Friendship is powered by two Rolls-Royce Dart R.Da. 6/511 engines, which produce 1,600 shp. at takeoff. Aircraft fitted with R.Da. 7/528s will attain 1,910 shp. for takeoff power. Friendship seats up to 48 passengers.

Assembly line of Fokker factory at Schiphol, Amsterdam Airport, is led off by nearly completed F-27 Friendship in Aer Lingus (Irish Airlines) markings, the third which was manufactured for that company. Second in line is first F-27 for Braathens South American & Far East Airtransport. Adaptation of Fokker engineering drawings to U.S. techniques resulted in considerable engineering and retooling costs for Fairchild. Company pegged part of a $5 million six months loss to this factor (AW July 28, p. 31).

AIRLINE OBSERVER

► Cooling-off period allowed by International Air Transport Assn. traffic conference following a breakdown in Cannes of talks on a proposed jet surcharge (AW Oct. 27, p. 26) will prove to have been some help in settling the controversial issue. However, because of the inflexible stand on the subject by some governments, a resolution still will not come easily when the conference is resumed in Paris next month (AW Nov. 24, p. 45). Chances are strong that delegates to the conference will agree to small jet surcharge as the only means of preventing the industry's fare structure from being thrown into an open-rate situation.

► Local-service airlines last week absorbed overloads of Christmas airmail created by strikes against American and Eastern. Post Office Department contracted with the local-service operators to carry mails in certain areas where severe reductions of trunkline service threatened to backlog mails. Gap between Dallas and Los Angeles normally covered by American was handled by extra flights contracted for by the Post Office with Western and Braniff. Post Office reported no delay in airmail deliveries between the Christmas rush period. No air freight tie-ups were reported and none are expected in the future since January and February are historically light months.

► Airlines last week were rapidly reaching a limit on the number of extra sections they could operate to pick up overflow traffic from struck airlines. At least two carriers reported that crew time for the month was reaching a maximum and that extra flights would necessarily be restricted as a result.

► Railroads and buses are reaping big benefits from the airline strikes. To accommodate Christmas rush, surface carriers last week placed all available rolling stock into service. However, most such traffic was short-haul business. Long-haul passengers unable to obtain airline space appeared to be canceling holiday travel plans.

► Federal Aviation Agency this week moves into the spotlight as the single independent agency responsible for all activities pertaining to air navigation facilities throughout the U. S. Majority of top-level positions within the agency will be filled by the end of the week.

► Civil Aeronautics Board "use it or lose it" policy in connection with local-airline service has prompted action from at least one city. Threatened with the loss of Southern Airways service because of the low volume of traffic generated, Greenwood, S. C., has launched a campaign urging citizens to buy and use at least one ticket on Southern Airways prior to Dec. 31 and at least six tickets during 1959. Purpose of campaign is to boost the number of passengers emplaning Southern at Greenwood from the present 3.4 daily to the Board's policy standard of five.

► British Overseas Airways Corp. has asked the British Air Transport Advisory Council for permission to operate scheduled service between London and Frankfurt. Request is aimed at improving its competitive position against TWA and Pan American, both of which now operate into Europe through London. Early this year, BOAC sought permission to operate schedules between London and Paris. Air France, however, opposed the proposal on grounds that BOAC and British European Airways flights between the two capitals would outnumber those operated by Air France.

► Federal Aviation Agency will use senior members and cadets of the Civil Air Patrol to conduct a survey of air traffic control activities. CAP will quiz pilots of private, nonscheduled and transient military aircraft at 245 civil airports in 21 states during four-day periods from Thursday through Sunday of each week beginning Jan. 8. Data obtained will be used to simulate aircraft activity patterns.

► Poland has placed a heliport in operation on top of Warsaw's 11-story Grand Hotel and is making test helicopter flights between the hotel and Okecie Airport. Regular helicopter air taxi service is scheduled to start over the route early in 1959.

SHORTLINES

► Aeroflot, Soviet State-operated airline, began regular Moscow-Cairo air service earlier this month with twin-jet Tu-104 transports.

► Bonanza Air Lines reports a 25% gain in passengers carried during the first 10 months of 1958 over the same period of 1957. Total for the period: 153,036.

► Delta Air Lines has purchased seven Boeing Turbo-Starters and one spare engine for ground support of the carrier's new jet equipment for delivery in April. The units will provide engine starts for Delta's Douglas DC-8 and Convair 880 jet transports.

► Flying Tiger Line reports a November freight revenue of $1,112,230, a 24.2% increase over November, 1957, and the fourth consecutive month revenues have exceeded $1 million. The all-cargo carrier also noted a heavy rise in over-all business, particularly at Detroit where November traffic was 112.1% above that of a year ago.

► Lake Central Airlines reports a 22% increase in aircraft boardings for November, 1958, as compared with November, 1957. The local service carrier attributed part of the increase to strikes which grounded other airlines serving the area. Lake Central has added one daily evening flight between Chicago and Indianapolis due to increased traffic and strike-caused reduction of service.

► Ozark Air Lines flew 36,930 passengers during November, an 8,260 passenger increase over November, 1957. Ozark also operated extra sections due to strikes on other carriers in its area. Ozark said the extra flights accounted for 1,469 passengers. 102 charter flights accounted for 1,926 passengers, an all-time record for the carrier.

► Piedmont Airlines has placed its Fairchild F-27 turboprop transport into operation at four more cities on its routes. Ashland, Ky./Huntington, W. Va.; Hickory, N. C.; Kinston, N. C., and New Bern, N. C., will be served on a one flight a day basis. Also, Piedmont plans to begin F-27 service in Richmond and Norfolk, Va., and Charleston, W. Va., on Jan. 4 and into Louisville, Ky., and Charlotte, N. C., on Jan. 15, each on a daily basis.

► United Air Lines has completed a new hangar at San Francisco International Airport. The three-story building is 310-by-363 ft. and can accommodate four Douglas DC-8 turbojet transports and two DC-7s at the same time.

Ramp System Designed as Jet Age Aid

By Craig Lewis

Dallas—New ramp system using turntable and tow track techniques is being offered to airlines and airport operators as a means of saving space and improving aircraft handling as turbine powered transports come into service.

The system is designed to turn aircraft around in less space than they use turning under their own power and to position them correctly for fixed servicing installations. It will also tow the transports away from the passenger gate so they can start their engines where noise and blast are less of a problem.

Designed by Paul D. Bolton, the system will be manufactured and installed by Space Corp. Bolton has joined the company as project director for the Bolton Aircraft Positioning and Locating System.

Bolton system is designed to handle piston and turbine-powered transports of various sizes, but its greatest advantages would lie in the space saved in handling the large turbojet aircraft and its compatibility with the fixed servicing facilities which are planned to turn jet flights around quickly.

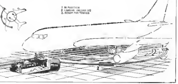
With this system, a pilot taxis his aircraft straight into a gate position, putting his nose wheel on a tracked dolly and the main gear on a turntable built into the ramp in front of the gate position. Brakes are locked and engines cut, and ground crewmen plug in auxiliary power, air conditioning and interphone facilities from a fixed island in the turntable.

Nose wheel dolly is activated, and it pivots the aircraft around to a position parallel to the passenger loading building. Then it is in position for quadrant fueling and servicing from any other facilities built into the ramp area.

A transport using the system can be weighed before, during and after loading and servicing operations, and the system can also be used to compute the center of gravity. This feature replaces current estimating techniques.

When the aircraft is ready to go, the nose wheel dolly is again activated, and the aircraft swings around to a third position. At this point, it is connected by tow bar to a drag mule projecting from an underground track and is towed along the track to a fixed point used for engine starts. This starting area can have permanent fire fighting facilities, as well as engine starting aids.

Bolton points out that the aircraft can be turned around at the gate within its longest dimension. Comparing this factor with the room required to turn a transport around under its own power,



TRANSPORT has been rotated to the third position and connected by tow bar to an underground drag mule which will tow it along the track system to the engine start pad.

he points to the economies available in space saved. For example, the Bolton system turns the Boeing 707-420 jet transport around in a circle with a 158 ft. diameter, while manufacturer's specifications say it has a turning diameter of 218 ft. under its own power.

Bolton points out that about 160 ft. is the most ramp frontage now generally allowed for large transports, and that the Bolton system would allow jet operations within these ramp limits at currently existing gate positions. In construction of new terminal facilities, the system would allow airport operators to cut down on the concrete area for handling jets. With the 707-420, a total of 17,750 sq. ft. of concrete could be saved at each gate.

Fixed service facilities allow the airlines to eliminate mobile service carts and trucks which snarl ramp traffic. Bolton says that a key feature of the system is that it is compatible with such built-in facilities and that it positions the aircraft properly for their use.

Use of a track system to move transports from the ramp area would mean that the airport operator would have precise control over ramp traffic routing. The pilot would control the speed of the drag mule from the cockpit through a control switch and by using his brakes. But he would have to follow the track system through the ramp area. After the drag mule is disconnected at the engine start pad, it retracts below ramp level and can be run through the system to another assignment without disturbing surface traffic.

Dimensions and specifications for the system are not rigid because it will have to be tailored to any airport facility that chooses to buy it. But the turntable will probably be 45 ft. in diameter because that is a width that can accommodate all sizes of piston and turbine-powered aircraft now in production or commercial use. The pit to accommodate the turntable mechanism will be about 6 ft. deep, and the turntable will use an electric-powered gear drive under the current plan.

There are elevating mechanisms at three points along the dolly track. When the nose wheel is taxied onto the flush dolly, the dolly is raised slightly to track level so it can travel freely when the turntable rotates. It is lowered at the second position when the aircraft is parallel to the terminal facility, then raised again when the aircraft is rotated to the third position where it will enter the track system to leave the ramp area.

The track system will be laid in a channel cut in the ramp. Bulkheads will support flush plates which are slotted to allow passage of a projection from the underground drag mule which connects with the aircraft tow bar. The drag mule will be a self-contained unit powered by a 200 hp. electric motor. It will be gear driven by meshing with geared tracks along the walls of the channel. System will be heated to keep it defrosted and give it an advantage over tractors which have traction troubles towing aircraft on icy ramps.

Since each installation will be tailored to the airport that uses it, equipment will vary, and so will the length of the track system. Under these circumstances, it is difficult to quote a unit price for the system. But in a typical case, the cost of the turning mechanism and controls, a 45 ft. turntable, two nose wheel dollies and 100 ft. of track would be about $145,000 installed for each unit if 10 or more are ordered. Cost of just one such unit will run about $245,000.

GE Studies 400-Day Nuclear Power Unit

By J. S. Butz, Jr.

Washington—One megawatt power package for space use based upon an extrapolation of the state-of-the-art curve to 1965 is being considered by General Electric scientists.

The General Electric paper indicates that it should be possible to get more than 400 days of continuous unattended operation from a nuclear closed gas-cycle, turbine-driven alternator system after about six more years of work.

E. Schnetzer and W. Corliss of the General Electric Flight Propulsion Laboratory presented a preliminary design type paper at a recent meeting of the American Nuclear Society on an electrical power generating system that could be coupled to any of several low thrust ion plasma or magnetohydrodynamic propulsion systems that are satisfactory for a number of satellite and interplanetary missions.

Basically, the proposed GE power package is a closed cylindrical system using inert helium gas as the working fluid to cool the generator and as gas bearings. The gas is heated to approximately 2,600 deg. R as it passes through a nuclear reactor which uses ceramic fuel elements made up of $U^{235}O_2$ dispersed in a beryllium oxide matrix.

The hot gas then drives a 12-stage molybdenum turbine which, in turn, drives a compressor and an induction alternator that produces one megawatt of electrical power.

After the helium has been expanded through the 12-stage turbine, it is passed through a 16,800 sq. ft. radiator where it is cooled from the turbine discharge temperature of 1,818 deg. R to 675 deg. R.

This radiator has to dissipate 6.8 mw. of power for the overall efficiency of the cycle is about 16%.

Radiator discharge helium is used to cool the generator and then passes into a 41-stage compressor which raises the pressure to 300 psi. This high pressure gas then is ducted through the reactor and into the reactor and heated. The gas is expanded to 100 psi. pressure through the turbine.

In takeoff configuration, this system is a relatively small package. The reactor, generator and turbomachinery are hermetically sealed in a shell that is 17 ft. long and one foot in diameter at the narrow section. The large radiator which is extended in three great sheets during flight above the atmosphere is wound around the reactor, generator, turbine package at takeoff.

The system represents a major step beyond today's technology in several respects, but the authors feel that there are no design and material obstacles that cannot be removed within six years.

Portions of this proposed system that will require the greatest advance in the state of the art as known today are:

- **Ceramic fuel elements and reflector** of the nuclear reactor that must have a lifetime of 10,000 hr. at more than 2,600 deg. R.
- **Molybdenum bladed turbine** that must operate at 24,000 rpm. and have an inlet temperature of 2,600 deg. R.
- **Techniques for keeping the radiator** operable in the presence of large numbers of meteoroids.

Primary reactor problem of obtaining long fuel element lifetimes at elevated temperatures are not the only aspects of the reactor design that are not clearly understood at the present time.

These additional problem areas include gamma and neutron scattering from the radiator, secondary gamma production in the shields and structure and the evolution of fission gas from the fuel elements.

The General Electric scientists mention several design details that would be necessary in this advanced reactor. Beryllium oxide moderator slabs would support the fuel elements and be made in short lengths to alleviate the thermal expansion problems. The reflector also would be made from four-inch-thick beryllium oxide sections, but they would not bear any structural load.

The diameter of the fuel element core would be 20 in. and there would be no thermal shield between it and the pressure shield which would be made of .25 in. molybdenum. The pressure shell would be cooled by radiation to space and to the helium working gas.

Control over the reactor temperature would be obtained through rotating drums faced with boron carbide.

Shielding of the reactor in the case of manned vehicles would be accomplished solely through shadow shields placed between the reactor and the crew compartment. In the design considered in the GE paper, the crew is placed about 40 ft. from the center of radiation. The object is to place the compartment in the middle of a 15 deg. cone of safety so that the dose rate is kept within an acceptable range.

A partial collar of U^{238} is specified for the gamma shield and a quantity of lithium hydride would intercept the neutrons.

Turbine blades are the most critical part of the rotating machinery in the GE power package, and their limiting factor is creep when operating for 10,000 hr. at 2,600 deg. R. Molybdenum alloys now under development appear to be able to take this temperature. Some of them are reportedly able to operate in this heat at 24,000 rpm. and not creep more than 0.2%.

All of the rotating machinery is planned to run on gas bearings. Presently known lubricating oils are ruled out because of the intense radiation from the lightly shielded nuclear reactor. Compressor exit helium is bled off to provide the bearing gas.

The projected compressor has 41 stages and the turbine 12—the large number of stages being attributable to the low atomic weight of the helium working fluid. Compressor design is simplified by keeping all of the 41 stages nearly identical.

The alternator specified for the space power system is a brushless induction type which produces three-phase alternating current at 6,000 v. and 400 cycles.

The large thin walled radiator is listed as a severe design problem because of the requirements for low weight, low internal pressure losses and wide temperature range of operation. Main problem is reducing meteoroid damage. Present estimates of meteorite size and frequency preclude the use of heavy material to prevent penetration of the radiator because of the weight penalty involved.

Therefore, the design must include a make-up gas supply, provisions for leak detection and safety valving. With this system, banks of tubes could be closed off in the event of puncture but it does not offer positive guarantee against the loss of working fluid.

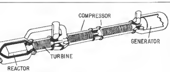
One hope for reducing the radiator area required as well as the total system weight, is to raise the turbine inlet temperature. If reactor and turbine technology could advance to the point that 4,000 deg. R could be tolerated for 10,000 hr., the radiator area would drop from more than 16,000 sq. ft. to less than 4,000 sq. ft. and system weight could be reduced about 30%.

In the General Electric concept, the radiator would be wrapped around the body of the vehicle while it was propelled to orbital speed by chemical or more powerful nuclear power systems. Then the radiator wings would elastically spring into the extended position as soon as the restraints were removed.

Chemical turbine would be used to bring the rotating machinery up to speed while the reactor is being brought up to operating temperature and until self-sustaining conditions are achieved. Hydrogen peroxide would be suitable for a fuel for this turbine.

No modulation of the power output would be attempted; excess would be dumped by filaments or other sinks.

As a typical application for their proposed power package the General Electric authors described a 20,000 lb. vehicle using a cesium ion drive that would produce 3.6 lb. of thrust at 73% efficiency and a specific impulse of 9,600 sec. Such small thrusts would be adequate to keep a vehicle in a relatively high orbit by overcoming drag and would be adequate for long term interplanetary travel. The General Electric power package also would make it possible to carry a great deal of equipment in a reconnaissance satellite for surveillance and communication.

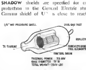


INTERNAL view of the hermetically-sealed power package shows the reactor, 12 stage molybdenum turbine, 41-stage compressor and the induction alternator.

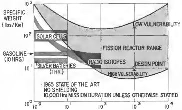

LAUNCHING configuration for GE electrically powered vehicle has flexible metal radiators wrapped around outside for low drag.

SHADOW shields are specified for crew protection in the General Electric study. Gamma shield of U is close to reactor.

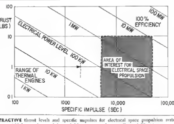

RADIATORS are extended in three great sails totalling 16,800 sq. ft. when in orbit.



REACTOR specified in the General Electric study is beyond the present state of the art, but is believed possible in 1965. It operates at more than 2,600 deg. R.



SPECIFIC weights for several different types of electrical power supplies are shown as a function of the power they produce, the General Electric study indicates.



ATTRACTIVE thrust levels and specific impulses for electrical space propulsion systems begin at 100 kw. and extend beyond 10 mw., according to General Electric.

Much Study Must Precede Man in Space

By Brig. Gen. Don Flickinger

Brief mention only will be made of this most interesting topic of biologic research in space vehicles since there are a number of high level committees now at work under the auspices of the National Aeronautics and Space Administration and the National Academy of Sciences on the uses of earth satellites in the furtherance of basic life science research

When the time comes in the progress of our space technology that we can put vehicles into space where and when we want them and either return or visit them at will then we will have a space laboratory of inestimable value to the fundamental life scientist

The ability to observe growth and form in tissue cultures and rapidly maturing species in a zero gravity field will of itself alone be worth the expense and effort of the experiment As my esteemed colleague Dr Otto Schmidt put it at a recent conference, "There is an important philosophy to be established with those in charge of our space programs and that is, not only should it be the idea to get biology into outer space, but also to use the outer space for biology"

As regards manned space operations, I believe it can be safely stated that some additional animal biosatellite experiments need doing before attempting to send our first man into orbit Both the Russians and we have recovered large and small sub human specimens from space-probing rockets but no one as yet, to my knowledge at least, recovered an orbiting vehicle intact, let alone one with viable tissue aboard

I don't think there is much question but that such an experiment will be carried out successfully in the relatively near future, and once having been done could yield the following pertinent information

- **The animal would provide** the necessary viable test bed to determine the efficiency and reliability of our life support system and validate our estimates of metabolic requirements per unit time
- **Next, it would provide** a biologic standard to calibrate against the actual recorded energy dynamics imposed upon the vehicle during the launch and re-entry phase While in orbit considerable information would be obtained on the efficiency of our heat and humidity control mechanism which is of vital importance to both animal and man alike.
- **Through optimal use of** power and telemetry channels, plus ingenious sensing much could be learned of the effect on the vital systems of the organism in the gravity-free space environment
- **With careful selection** of species and pre training in various types of operant and respondent tasks the animal could give us considerable insight into the performance capabilities of a man in orbit
- **Finally, the viable payload** would provide a most needed operational test of our search and recovery techniques which, when it comes time for the human flight should be well-nigh foolproof It would indeed be almost the ultimate irony to make man survive all the rigors of the space mission only to lose his life through some unforeseen or untimely event after he had returned in reasonably good condition, to the earth

Of all the biological hazards involved in space operation, that which involves the exposure of living tissue to ionizing radiations is perhaps the most important and certainly the one with most far reaching consequences into the future

Ionizing Radiations

Man and his biologic predecessors have never lived in an environment containing as one of its natural constituents, ionizing radiations and, therefore, no biological organism has ever been faced with the necessity to adapt itself to such a physical threat in order to survive and procreate itself Animals and man can neither detect nor protect themselves from significant intensities of ionizing radiations in their environment

> **Biomedical Study**
>
> **Biomedical problems are among the greatest remaining to be solved before manned space flight becomes a reality In a paper presented recently before a meeting of NATO's Advisory Group for Aeronautical Research and Development in Copenhagen Denmark Brig Gen Don Flickinger outlined his views on the biomedical aspects of space flight Because of the thoroughness of his survey, Aviation Week is reprinting his paper in three parts This is part two Gen Flickinger is assistant to the commander of Air Research and Development Command for bio-astronautics, assistant deputy commander for research, and surgeon to ARDC headquarters**

In space operations we must concern ourselves with the radio-biological hazard as emanating from three possible sources first those radiations intrinsic to space itself second, those produced as by-products to the use of nuclear energy as power in the vehicle, and lastly, man made contamination of space either accidentally through the use of nuclear power units or purposefully with nuclear weapons Whatever the source, however the implications on man's future capability to explore and exploit space are of considerable magnitude and complexity

In the area of space intrinsic radiations, the most urgent need is for additional physical data on the nature and intensities of the radiation fields to be encountered The reports on the Van Allen phenomena as compiled from Explorer IV measurements suggest that present concepts for manned space exploration may undergo rather drastic changes or at least be carefully re evaluated with specific consideration of the following points

- **The necessity for** and feasibility of shielding, and the influence of such on capsule design
- **The possibility of** using magnetic deflection for protection against high-energy charged particulate radiation
- **The possibility of** using these charged particles as a source of power and energy to offset the payload loss imposed by shielding requirements

The preliminary analysis of the data received from the National Aeronautics and Space Administration Air Force moon probe "Pioneer" offers some bit of encouragement as regards the possible depth of the Van Allen layer, though in no way alters the significance of the Explorer findings

Data readouts taken from the omnidirectional integrated ion chamber in the Pioneer show a gradual decrease of radiation intensities from the 10,000 mi to the 60,000 mi level with the latter figure being approximately one sixth that of the former No cross correlation or calibration of the measurements from Pioneer are possible as yet with those obtained from Explorer but it appears that the peak band of intensity would be encountered somewhere below 1 5 earth radius, or under 6,000 mi altitude

Regardless of this slight encouragement which is contained in this preliminary Pioneer data a complete and valid assessment of the total radiobiologic hazard in space must await the acquisition of the following information

- **Measurements of the flux** density and energy distribution of heavy primaries above the earth's atmosphere The continuation of our balloon flights and high altitude probes offer the most immediate potential for obtaining these data.
- **The development of** a physical means of monitoring primary cosmic ray hits in biological materials And specifically in this connection to find a reliable method of locating and identifying primary particle tracks and determining both their angle and depth of penetration The excellent work started by Dr Herman Yagoda at the ARDC Cambridge Research Center on this problem deserves active support and augmentation
- **Energy spectral measurements** of the Van Allen layer with more elaborate pulse scintillator/discriminator combinations than were possible in Explorer IV Either widely orbiting satellites could be used for this purpose, or as an alternate back up vehicle, a high altitude space probe fitted with various cross sectional threshold detectors could be used The only problem in using the latter type of vehicle is the necessity to recover the payload in order to make the necessary radiochemical analyses of the detector material in order to extract the data
- **A determination of the type,** quality, and intensity of secondary radiation produced inside the space vehicle since much of the total radiation dose imposed upon the occupant could emanate from secondaries produced by the interaction of the primaries on the space vehicle itself
- **The mapping out** of a circumterrestrial pattern which would relate intensities of the Van Allen phenomena to altitude, latitude, and time

Much Data in Hand

Pending the acquisition of this rather formidable amount of physical data the space bioscientist is far from bereft of useful biological effects data in making a valuable contribution to the initial man in space team effort

The armed services, Atomic Energy Commission and the U S Public Health Service have done excellent work in this area over the past 15 years and have compiled a commendable amount of information on the acute and chronic biologic effects of ionizing radiations

The Air Force effort, centered at the School of Aviation Medicine under the able direction of Col John Pickering, has produced an excellent set of crew tolerance standards which have considerable potential application to the space radiobiologic hazard problem His data on biologic effects has been carefully compiled and correlated and was obtained from a study of animal exposures, survivors of Hiroshima and Nagasaki victims of nuclear accidents and selected cancer patients under X ray treatment

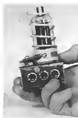
It is quite likely that, once the space radiation intensity measurements are made this group will have a ready answer for the very timely and vital question—man in space how deeply and for how long?

The problem of the heavy cosmic primaries (nuclei of elements with numbers greater than 6) deserves some additional mention despite the fact that its immediate implication in manned space operations has been far overshadowed by discovery of Van Allen phenomena

Much of the Air Force effort in delineation of this hazard has been carried out under the direction of Lt Col David Simons in the ARDC Aero Medical Field Laboratory at Holloman AFB N M Using high altitude balloons both animal and human subjects have been exposed for appreciable durations at altitudes which approach space equivalence in terms of cosmic primaries

Data from these experiments indicates that the terminal portion of a heavy primary particle track (so-called thin down portion) is most injurious to biological tissue because of its extremely high linear energy transfer plus the significant radius of its broad track. Further data indicates that the heavy nuclei responsible for the thindown phenomena are found only at geomagnetic latitudes above 50 deg latitude

Balloons launched above this latitude can maintain the specimen in continuous exposure to the maximum of biologically significant hits, while in comparison an earth satellite launched in an optimal polar orbit would provide maximum exposure only during 40% of its total orbital period At the present time and with current quoted rates for the price per pound of payload in orbit, this fact gives some comfort to the space radiobiologist



Lunar Probe Avionics

Transmitter used in Air Force Pioneer I lunar probe, intended to transmit back television picture of moon's surface weighs only 2½ oz. yet can deliver 50 watts output Built by Naval Ordnance Test Station engineers, the crystal-stabilized transmitter has tank coil around output tube

Simulating Space Energies

The possibility of reproducing the mass energies of the significant cosmic primaries in a ground laboratory facility is a most exciting one, for this would provide us with a real break through in the accurate evaluation of this particular space hazard

The key to the problem lies in the possibility that a heavy primary striking a vital brain center such as the hypothalamic region could inflict irreversible damage which would result in a serious impairment of the function and viability to the human occupant

It is fortunate that an international effort is being vigorously prosecuted toward the objective of heavy primary simulation in ground facilities at Brookhaven National Laboratory, the Radiation Laboratory of the University of California, here in Denmark at the University of Aarhus, and at the University of Bonn in Germany

The work of these groups involves the use of high-energy particle beams and low-energy X-rays to produce topical neuropathologic brain lesions which can be correlated with demonstrable changes in biologic function and patterns of electrical activity in the brain

Perhaps, through acceleration and increased support to this important program we may have the answer to this particular space intrinsic biologic hazard by the time our manned space vehicle is ready

The pioneer man-in-space will be faced with a complex of psychological factors, the like of which has no past counterpart in human experience The inherent danger of the mission, its many unknowns as regards his viability and survival would, of themselves alone, comprise a heavy load of stress on his psyche Yet there are many others to be considered which yield much less to an accurate pre-mission evaluation

Isolation, confinement with its attendant restriction of physical activity reduced sensory inputs prolonged weightlessness, disorientation with possible lack of vehicle altitude control all are major factors of concern in attempting to select and prepare a human component with the maximum index of reliability

The majority of our research efforts in this area have a basic objective which might be simply stated as follows To minimize and counteract such emo-

tional stresses as might impair his effective performance in space flight

Much excellent work is being done on this problem by psychologists, psycho-physiologists, and psychiatrists the world over and I will herein present briefly only that work going on in our Air Force ARDC laboratories. This work can be grouped into four general categories as follows

- **The identification** of potential sources of disabling psychic stress within the space mission regime
- **The study of performance** and behavior under artificial conditions in which these identifiable stresses are simulated with as much accuracy as possible
- **The attempt to create** artificial environments and conditions which will satisfy human psychological needs during actual space missions
- **The application** of valid criteria and standards to the problem of selection, training, and conditioning of space members

In attempting to identify the potential sources of psychological stress, our workers have exhaustively reviewed the experiences and reported behavior patterns of those individuals who have faced danger, isolation, and exposure under terrestrial conditions

These have included such people as arctic explorers, mountain climbers, deep sea divers, and shipwrecked sailors

It is indeed interesting that many of the abnormal behavioral patterns reported by and on some of these individuals have been manifest in our subjects under conditions of isolation, confinement and sensory deprivation simulated with varying degrees of completeness

The results of these studies thus far completed may be summarized rather generally as follows

- **Close restriction** of physical activity is largely unacceptable, conversely, the ability to flex extremities and neck, shift position and occasionally assume a fair erect posture is a basic requirement. Interestingly enough, the individual may not take full and continuous advantage of his mobility but if he knows that he can move if he so wishes, then he is content
- **A visual reference** both internally within the capsule and externally to provide some degree of spatial or geographic orientation plus the ability to control levels of illumination is perhaps next most important
- **A two-way voice communication** with an outside or ground source and preferably with an individual or individuals with whom he has previously established a strong identification as regards the objectives and successful outcome of the experiment
- **Continuous orientation** in time with a definite limit or goal set for the duration of the experiment. Without some means of time orientation, the sense of time passes is fairly rapidly lost and this becomes quite annoying and disconcerting to the subject the longer he remains without an accurate reference. When he attempts to estimate the lapsed time of the experiment he almost always errs on the short side
- **The ability** to eat, sleep and carry out assigned psychomotor performance tasks on a schedule or rhythm which reasonably duplicates his normal one in behavior and performance are quite acceptable

However attempts thus far to significantly deviate from his normal psychophysiological rhythm and still maintain the same degree of efficiency in performance have not met with much success.

No Single Type Found

In choosing our subjects for study we have attempted to sample a fairly broad spectrum of personalities and occupations. Medical doctors engineers, administrators, scientists, standard pilots, SAC pilots, test pilots, and Navy frogmen have all been studied and within each specific group we have had both successes and failures

There seems to be no specific type of personality which uniformly shows a good durability to the artificially imposed psychological stresses. Instead those subjects who perform well appear to have a good capacity to harmonize internal needs and drives with the external realities of the situation in a mature and flexible manner

Contrary to some statements of opinion in the popular literature, individuals with neurotic or psychotic tendencies should be most assiduously screened out and eliminated from consideration. The expressed contention that schizoid or other abnormally withdrawn individuals should be chose for their "presumed" increased tolerance for isolation and sensory deprivation has not proven to be valid in our hands.

Successful subjects demonstrate uniformly a strong motivation toward the achievement of the entire objectives of the experiment but not for purposes of satisfying any personal need for recognition

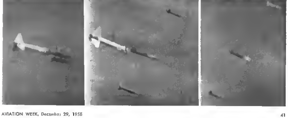
Volunteers with strong needs to "prove something" to themselves or to test their own personal fantasy of invulnerability are uniformly fairly bad risks. Freedom from impulsivity is another desirable trait for the space man must act economically when action is required yet refrain from purposeless activity when inaction is appropriate to the actual situation. He must be able to tolerate stress situations passively without requiring motor activity to dissipate anxiety

It is extremely difficult to predict just how long a properly selected trained, and conditioned individual can remain in space, even assuming that most all of his psychological needs can be ingeniously engineered into the system. We can never simulate the total situation as it will actually occur particularly as concerns the complete detachement from the earth and this could have far greater psychological impact than we now suspect

However, if forced to guess, based upon what we know now, I would say that under ideal conditions we could expect man to remain in space flight without emotional and behavior deterioration for a period from 10-14 days. For periods beyond that we have much more to learn about the interplay between emotions, brain mechanisms and performance

Rocket Designed For Parachute Tests

New rocket test missile designated Cree will be used by Wright Air Development Center to test 14-18 ft. parachutes for manned aircraft escape capsules, missiles and drones, at speeds up to 3,040 mph. Triple heads (above) contain parachutes. Test cluster is ready for ejection (below, left) and heads separate from booster (center) to fly parallel (right) before parachute deployment. Cree was conceived by Rudi Berndt (at right in top photo) and developed by Cook Research Laboratories under WADC contract. Previous tests were limited to ground-level devices at speeds up to Mach 1.6.



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USAF Contracts

Following is a list of unclassified contracts for $25,000 and over as released by Air Force contracting offices

HEADQUARTERS AIR FORCE OFFICE OF SCIENTIFIC RESEARCH, ARDC, Washington 25, D C

Trustees of Princeton University, Princeton N J, research on "Molecular Problems in Heat and Mass Transfer" (AF 49(638)-32) $46 000

Regents of the University of New Mexico, Albuquerque N M, continuation of research on "Extensive Air Showers in the Cosmic Radiation (II)" (AF 49(638)-34) $42 000

Franklin Institute of the State of Pennsylvania, Philadelphia Pa, continuation of a study of the "Plastic Deformation of Metals by the Observation of Single Dislocations (AF 49(638)-183) $35 800

University of Chicago, Chicago Ill, research on "Nuclear Emulsion Research with High Energy Accelerators" (AF 49(638)-400) $77 870

Regents of the University of California, Berkeley Calif, continuation of "Basic Research in Microwave Electronics" (AF 49-(638)-100) $80 000

Westinghouse Electric Corp, Baltimore Md, research on "Methods and Techniques for Space Flight" (AF 49(638)-490) $40 951

Atlantic Research Corp, Alexandria Va, experimental study of "Turbulent Flames in a Two Dimensional Open Burner" (AF 49(638)-518) $49 738

Yale University, New Haven Conn, continuation of "Investigation of Electron Nuclear Interactions and Related Problems" (AF 18(600)-671) $34 9 0

Board of Governors Wayne State University, Detroit Mich, research on Surface Phenomena in Semiconductors and the Growth of Semiconductor Crystals" (AF 49(638)-155), $110 000

HEADQUARTERS ROME AMA, USAF, Griffiss AFB N Y

International Business Machines Corp., New York City, repair and refurbishing of RAM equipment as may be required to restore to a like new condition Air Force equipment upon which work is to be performed (PR MH 8172-58848) $38 289

International Business Machines Corp., New York City, modification kits AN/FSQ-7 and AN/FSQ-8 for SAGE Equipment (PR MR-8-PP 19815 MR 8 PP 58774) 127 each $270 944

Bristol Tool and Forging Corp, Brooklyn, N Y, S/N 6210 572 2956 base assembly airport marker light in a/w MS drawing 25039 specification MIL-L 26182A (IFB 30-125-59-92E) 8 477 ea $123 742

Reverse Electric Manufacturing Co Chicago, 6210-NSL light marker airport approach type MB-2 without red filter, accommodates 1 ea 166 200w, 6 6 ampere annual end prong lamp in a/w specification MIL L-26184(USAF) dated Mar 3 1958 and amendment no 1 dated Feb 28 1957 amendment no 2 dated Feb 13 1958 (IFB 30-635-59 S-N), 7,415 ea $50 374

Navy Contracts

Following is a list of unclassified contracts for $25,000 and over as released by U S Navy contracting offices

DEPARTMENT OF THE NAVY Bureau of Aeronautics Washington 25 D C

Loral Electronics Corp New York City, conversion kits in accordance with specification MIL N 18307A(Aer) NOas 59-0174-f(TP-31-1490-59) $196 437

Packard-Bell Electronics Los Angeles 10 man-months of field engineering services in the maintenance repair and operation of aircraft electrical and electronic equipment NOas 59-4049 s(MA-60-854-59) $33 314

Vertol Aircraft Corp Morton Pa, design develop fabricate test and furnish two complete experimental units of a helicopter towing winch NOas 58 6030-c(AV-34-2710-58) $141 921

Technicians Adjust Jupiter IRBM Engine

Final adjustments on an engine which will be used in the U S Army Jupiter intermediate range ballistic missile are made by technicians at Canoga Park, Calif, plant of North American Aviation's Rocketdyne Division Similar engine was used in moon probe attempt

Consolidated Diesel Electric Corp., Stamford Conn 27 man-months of field engineering services for NC-5 and NC 7 type power plants NT-1 electric test units and MC 1 runway vacuum sweepers NOas 59-4073-s(SE-73-4026-59) $38 060

Defense Electric Products Radio Corporation of America Camden N J study and analysis of final value guidance techniques as applied to air to-air and air to-surface missiles NOas 58-6832-c(AV 31-2768-59) $298 880

Eclipse-Pioneer Division, Bendix Aviation Corp Teterboro N J 36 man-months of field engineering services in the maintenance, operation and servicing of compass systems NOas 59-4062-s(MA 60-78-59) $52 560

Stewart-Warner Electronics Division, Stewart Warner Corp Chicago 30 man-months of field engineering services in the maintenance repair and operation of aircraft electrical and electronic equipment NOas 59 4126-s(MA-60-880-58) $73 585

Pioneer Central Division Bendix Aviation Corp Davenport, Iowa 30 man-months of field engineering services in the maintenance operation and servicing of oxygen systems NOas 59-4061-s(MA-60-784-59) $39 407

Del-Mar Engineering Laboratories, Inc., Los Angeles 24 man-months of field engineering services in the maintenance operation and servicing of Radop systems, NOas 59 4048 s(MA-60-801-59) $31 411

Grumman Aircraft Engineering Corp Bethpage L I N Y services and materials necessary for conversion of UF 1 aircraft to UF 2 configuration NOas 59 0707-(MA-63-750-59) $4 182 233

Sikorsky Aircraft Division United Aircraft Corp Bridgeport Conn 36 man-months of field technical services for HRS HO4S HO5S and HSS/HUS helicopters NOas 59 4054-s(MA 60-101-59) $ 2 810

Eclipse Pioneer Division, Bendix Aviation Corp Teterboro N J 50 man-months of field engineering services for aircraft electrical and electronic equipment NOas 59 4059 c(MA 60 885 59) $110 229

Beech Aircraft Corp Wichita Kansas target aircraft model KDB-1 in a/w specification SD-2814-1 NOas 59-0101-f(PD-32-1280-08) $8 547,387

Toledo Division, Continental Aviation and Engineering Corp., Toledo Ohio 45 man-months of field engineering services for gas turbine engines NOas 59-4028 s(MA-60-734-59) $63 677

Dynamic Electronics New York Inc Forest Hills, L I N Y 60 man-months of field engineering services for aircraft electrical and electronic equipment NOas 59-4068 s(MA 60-862-59) $81 740

The W L Maxson Corp New York City 18 man-months of field engineering services for fire control systems NOas 59-4982 s (MA-60 766-58) $40 888

AVIATION SUPPLY OFFICE, 700 Robbins Ave Philadelphia Pa

G Felsenthal & Sons, Inc, Chicago boards chart plotting internally lighted knee type N383 88918A (JD IFB 383 58-59) various $42,714

Autonetics Division North American Aviation, Inc Downey Calif control panel assemblies for use in Navy T-28 trainer, N383 58453A (383/221030/58) 140 ea, $65 100

Montrose Division Bendix Aviation Corp, South Montrose Pa transmitters pressure manifold for various aircraft N383 86776A (IFB 383-264 59) 771 ea $37 838

Lockheed Aircraft Corp Burbank Calif, interconnectors airframe structural parts for P2V-7 aircraft N383-5a126A (383/-222827/59) 270 ea $26,898

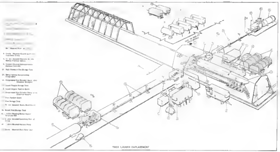
Tayco Ltd Santa Monica Calif bottle assemblies used on bomb bay doors for various aircraft N383/212120/59) various $66 683

The Cornelius Co Minneapolis Minn compressor assemblies for use on aircraft armament pneumatic systems N383 86642A (JD 383/217225/59) 112 ea, $171 033

G M Giannini & Co Pasadena Calif, services and materials necessary to overhaul repair modify and place in serviceable condition gyro controls N383 5a654A (383/216280/58) various, $40 840

Holley Carburetor Co., Warren, Mich kits overhaul and cure date to support fuel controls on J57-P18 engines N383-58836A (383/236077/59) various $35 550

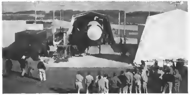
California Division Lockheed Aircraft Corp., Burbank Calif replacement motors for overhaul of WV-2 1 aircraft N383-88119A (383/234052/59), 83 ea, $28 787.



Drawing depicts Thor launch emplacement with numbers at left used to label various pieces of the ground handling equipment

Buildings on either side of transporter-erector at Thor site 75-1, emplacement No. 1, house major ground support equipment.

Thor Launching Site at Vandenberg AFB Becomes Operational



USAF's Thor intermediate range ballistic missile is partially enclosed in portable shelter (above). Front wall of cover slides to one side, main structure is rolled back to expose the missile. Below, the Douglas Thor is ready to be erected to the firing position

Transporter-erector elevates Thor to firing position. Missile is automatically elevated to vertical for the launching

Thor is erected to full vertical position (left) and rises from the launch area (right). This was the first training shot made by an 11 man crew of Strategic Air Command's 1st Missile Division's 704th Strategic Wing and inaugurated the operation of Pacific Missile Range and Vandenberg AFB (AW Dec. 22, p. 24). Azimuth heading of the trajectory was about 251 deg., range was approximately 1,250 naut. mi.

Sound Emerges as Major Jet Problem

By David A. Anderton

(This is the first of two articles on the problems and progress in turbojet noise suppression. The second will describe some of the development work done by Rolls-Royce Ltd., a leader in this work as part of the industry-wide attack on the noise problem.)

New and highly complex problems in sound suppression have sprung out of the entry of large turbojet engines into the commercial airline industry.

Millions of dollars and thousands of engineering man hours have been spent seeking solutions to the problems, and the final and definitive answer is not yet in sight.

Existing types of flyable suppressors for turbojets carry with them more disadvantages than advantages. In exchange for a small amount of silencing, airline operators must pay large amounts in specific fuel consumption.

Besides these tangible penalties they must also pay the intangible ones resulting from all the horror stories now circulating, retelling the old canards about physical injury, mental anguish and property damage caused by the noise.

This furor has produced a relatively small piece of the airplane which is needed for about one minute per flight, but which must be carried for the entire trip. Furthermore, this suppressor does absolutely nothing for the passengers, crew, airplane or operator. It contributes nothing to the safety or comfort or economy of the operation.

The only group benefiting from the use of suppressors is an almost infinitesimal—but not negligible—percentage of the population living in an irregularly shaped area under the possible climbout paths around an airport.

Old, but New

Sound suppression of itself is far from being a new problem. Architectural work in the field has been going on for years; so has work by industrial companies in silencing heavy machinery, power generation equipment and home appliances. In aviation, efficient static ground units have been developed for engine test cells, and mobile or transportable units have been developed and are in use to quiet the fearful racket of a military jet aircraft firing up on the line.

But there is not much that is old or familiar in the possible ways to soften the bellow of a 10,000 lb. thrust turbojet engine mounted on a moving airplane that must show a profit for its operators.

Practitioners in this new field have to be skilled in three engineering subjects: acoustics, aerodynamics and thermodynamics. These fields of knowledge are used in the measurement and analysis of noise, and in the design and development of silencers.

But on top of these should be piled a fourth skill in human factors, because noise—as different from sound—depends almost entirely on the subjective reactions of individual people.

For this latter reason, arguments arise on whether or not a suppressed turbojet is still noisy. This is why communities organize against airport noise, whether or not the noise is actually louder than the truck traffic past their front doors or the television receivers in their front rooms.

As in any technical field, the first approach to the problem is to understand the problem itself.

Physical Phenomenon

All noises are sounds, but all sounds are not noises. Sound is a physical phenomenon. It is a form of energy transmitted as a wave motion that can be generated or duplicated, measured and analyzed.

Noise is different. Most dictionaries agree that a noise is a loud or harsh or objectionable sound, but these defining adjectives apply to subjective human reactions. What is loud? What is harsh? What is objectionable? Those qualities can't be measured absolutely, but only by comparison. For example:

- **A cocktail party** produces a lot of sound, but it does not seem noisy if you are enjoying it in the middle of the crowd. But if you are trying to sleep in the apartment downstairs, it is noise.
- **A dentist's drill** produces a relatively quiet sound, yet it is a most objectionable noise to some people.
- **The modern jazz quartet** plays more quietly than a chamber-music group, but a classical musician might describe the efforts of the quartet as "noise."

Locomotives, too

A century ago, locomotives were blamed for " . . . waking babies, scaring horses, aiding insomnia and stopping chickens from laying." Half-a-century ago the popping of early automobile engines caused annoyance in small, quiet towns.

Today the picture is the same. Said a recent headline in a British paper: "Boeing 707 Spreads Terror, says MP." The reference was to a speech in the House of Commons by a Member of Parliament (MP) who said that when a 707 goes overhead, children run to their mothers, old people tremble for minutes afterwards, horses shake and older properties are in danger of crumbling.

Yet the noise level of the new jets shows less of an increase over familiar piston-engined planes like the Douglas DC-6 and Lockheed Super Constellation than those airplanes did over the DC-3. Objectively, some unsilenced jet aircraft now make less noise than DC-6s and Connies, and their noise fades much faster because of their increased flight performance.

But unfamiliarity with the different kind of noise—even though it is not so loud—leads people on the ground to react to the jets where they had tolerated the louder noise of piston engines.

So noise is many things to many people. These few examples show that noise is a function of the characteristic of the sound, the environment surrounding the hearer, repetition of the sound, its duration, its familiarity, possible associations with other subjective reactions such as pain and a host of other intangible factors.

Perhaps a good working definition of noise is to say that it is a subjective reaction, invariably one of annoyance, to sound. This leaves us no better off from a viewpoint of measurement, but it does begin to narrow down the problem area.

Measurement Possibilities

In the special case of aircraft noise, reactions are also subjective and highly varied. Some people object to the high-frequency whine of the jet compressor; some hate the low frequency rumble, and some are annoyed by the sympathetic vibration of a loose window or a stack of dinner plates when a jet flies overhead.

The only way to measure such subjective reactions is by comparison. The current standard for comparison of turbojet noise is the noise of existing airplanes, such as the Douglas DC-7C and the Constellation. Right or wrong, this standard is the only one available and is used to judge the effectiveness of present and future generations of sound suppressors.

This gives the designer of these units a starting point and a goal both in one package labelled "existing noise levels."

He turns to acoustic theory, aerodynamics and thermodynamics and begins the design approach that will eventually yield a suppressed noise that people are supposedly willing to tolerate because they now tolerate its equivalent.

To help understand some of the aspects of sound and noise, let's return to fundamentals.

Sound is a form of energy transmitted by wave motion. Its characteristics are those of frequency, amplitude, wave length and intensity. These parameters describe a sound, and conversely, any sound can be analyzed and broken down into these various parameters.

Theoretically, sound radiates on a spherical front from a source, and the intensity of sound at any point in the field is inversely proportional to the square of the distance from the source. In practice this "inverse-square" law hardly ever holds true outside of a physics laboratory. In turbojets, the nozzle produces sound that is highly directional and not at all generated by a source point.

The intensity of a sound is measured by the amount of energy transmitted in a second across an area at right angles to a line to the source. It is proportional to the square of the product of frequency and amplitude, and that product is also proportional to the average of the square of the unit pressure variation over a single cycle. The pressure is independent of the sound frequency.

Units for sound intensity are watts per square centimeter. But in fact, acoustic power is very, very small so that the basic unit of sound intensity is 10 to the −16th watts per square centimeter, or 1/10 of one-quadrillionth of a watt per square centimeter. For comparison, the intensity of a sound which is painfully loud to hear, such as a rocket motor, is less than 1,000th of a watt per square centimeter.

A human comparison is that it would take the harnessed sound power of 4 million people talking at once to light a 40-watt bulb.

Decibel Scale

The basic engineering unit used to describe sound loudness—which is a function not only of intensity but also of frequency—is the decibel. Zero on the scale is the threshold of hearing, corresponding to a sound that would have an intensity of 10 to the −16th watts per square centimeter.

The decible scale measures relative values of sound. A decibel corresponds to a ratio of sound intensities whose logarithm is 0.1; the ratio therefore is about 1.26.

For comparison, the sound intensity level in a quiet office is about 37 db., in a noisy office about 57 db.

Sounds beginning at about 90 db. affect the acuity of hearing; such noise levels are found and exceeded in the classic boiler factory, or in areas where riveting is being done in aircraft factories.

Sound intensity levels at about 120 db. begin to arouse discomfort. By 130 decibels, the hearer begins to get tingling or tickling sensations, and at about 140 db. true pain starts.

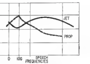
These upper values are the common intensities found with operation of unsuppressed jets. The noise field around a military aircraft running up on afterburner on the ground reaches 140 db. This is why ear protection is mandatory for line personnel working around these aircraft.

Attenuation

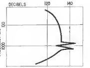
Actually, people living around airports never will get the full intensity of the jet engines, because of the attenuation—the reduction in sound intensity—with distance. It should also be pointed out that sound intensity measurements made with today's aircraft are made at some fixed distance, on the order of several hundred feet from the nozzle to be more representative of conditions at an airport.

Sounds are normally associated with hearing; if a sound has a frequency somewhere between about 20 and 20,000 cycles per second, it can be heard by the human ear. Lower orders of animals can hear higher-frequency sounds; bats fly blind by emitting and receiving an ultrasonic sound at about 50,000 cps. Lower frequency sounds are actually felt as separate pressure pulses rather than heard by the ear mechanism.

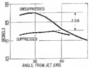
High frequency sounds can do physical damage to the human ear; the low frequency pressure pulses can produce a queasy feeling or nausea in some individuals. But most of the problems associated with commercial turbojet sound suppression center around the middle frequency range in the audible



COMPARISON of turbojet and piston engine sound intensities shows piston engine has peak noise level at low frequencies, while the jet engine produces its maximum noise in the speech frequency range.



TYPICAL sound spectrum for a turbojet engine operating at 90% power shows the high noise level over a wide frequency range. Two peaks are fundamental notes of the turbine wheel acting as a siren.



ATTENUATION peak-to-peak is measured as change in decibel readings between maximum sound level intensities of suppressed and unsuppressed jet engines. Parameter is used as one measure of suppressor efficiency.

Suppression: Expensive Problem

Suppression of the sound of commercial turbojet engines is one of the most expensive problems facing the aircraft industry today. Noise of the big engines has restricted takeoff performance of the big jet transports, excited property owners and has kicked off a multi-million dollar engineering development program in the United States and England. The first generation of suppressors, developed hastily for quieting the raucous racket of a turbojet, has imposed flight penalties on airline operators.

The future solution must be more satisfactory than the current approach to the problem.

Engineers working in this new area must be familiar with acoustics, aerodynamics and thermodynamics, and have some understanding of both individual and mass psychology. Aviation Week presents this two-part series on some of the problems and progress in turbojet noise suppression as background to wider understanding of the problem by the industry's engineers.

LOUDNESS level comparison between jet and piston engined aircraft shows difference of two noises. For a given decibel value, the loudness level is higher for a jet. Note also that some jets are quieter than existing piston-engined types.

spectrum of sound Some technicians have narrowed down the frequency field of concern even further by suggesting that it is only important to the speech frequency range from a few hundred to a few thousand cycles.

There is no question that turbojet sound is louder than that of a piston engine under equivalent environmental conditions But loudness is not the only difference The designer who is working to match existing noise levels soon finds out that the noise of a piston engine powered airplane and that of a jet-propelled airplane are not at all equivalent, any more than jet thrust is equivalent to shaft horsepower.

The difference is in the content of the sound itself The noise of a piston engine driving a propeller is largely a low frequency noise with maximum intensities at something under 100 cycles per second

Above that frequency, the intensity falls off quite rapidly so that in the normal speech range, masking is not too noticeable

Intensity Peaks

But turbojet noise is different, it contains all frequencies from the lowest to the highest, at almost a constant level of intensity, plus a couple of peaks due to the characteristic note of the turbine wheel which makes an excellent siren. This omnifrequency property is why the noise of a turbojet is sometimes called "white" noise It comes from the analogy between the spectra of sound and of color "White" as a color does not exist, technically it is the presence of all colors

Comparison of plots of sound intensities for a piston-engined aircraft and for a jet aircraft show how a jet produces much more masking effect in ordinary speech frequencies That is probably the major reason that a turbojet transport annoys people more than a piston engined plane They are most aware of noise when their own conversation or that coming out of a loud speaker is blanketed.

That is also why a successful suppressor is one which suppresses the mid frequency range, even if an occasional rumble still comes through

Measurement Techniques

Sound intensity level measurements are made under both static and dynamic test conditions

• Static tests are made in open air, either with the engine on a test stand or installed in an airplane The area around the measuring site has to be free of buildings or irregular ground so that reflected sound waves will not complicate the measurements. Measuring points are laid out on a fixed radius—typical values are 100, 200 and 500 ft —and at increments of angular position measured from the axis of the jet Results are plotted as decibels against angular position either on a polar plot or on rectangular coordinates

• Dynamic tests are made on the ground during flight conditions of a takeoff and climbout from an airport Measurements are made typically by stationing recording equipment at some arbitrary series of points measured from the start of takeoff run or from the end of a runway. Noise level recordings are made as time histories on tape or as a number of maximum intensities, recorded individually. Either way, the idea is to get enough data to plot sound intensity contours on the ground under an airplane as it climbs away from the field

Both techniques give comparative data for unsuppressed and suppressed jets One standard of comparison is obtained from the plots of decibels versus angular position in static tests Such plots show a peak value at some angle off the jet centerline the angle may vary between suppressed and unsuppressed jets, but for comparative purposes this makes no difference

Difference in sound intensity level between the two peaks of maximum decibels for silenced and unsilenced jets shows the reduction due to the silencer This amount of reduction is used as one measurement of the efficiency of the silencer and is called peak-to-peak attenuation.

Mixing Layer

The noise of a turbojet engine is caused by the turbulence of mixing of the hot, high-velocity exhaust jet with the cold, low velocity or static ambient air around the exhaust At the surface between jet and air, shear in the mixing layer is the mechanism that sets up the turbulence and which eventually produces the noise

Structure of the exhaust is conical, with a central core The noise intensity is a maximum at the end of the core High frequencies are generated near the nozzle, and most of the noise is produced in the first 10 diameters downstream of the exhaust nozzle

Either distance or artificial or natural barriers are the only possibilities to reduce the received sound of the jet Up until recently distance has been the controlling factor as far as flights of commercial airplanes are concerned Natural barriers, of course are only of value for static conditions of ground running and the artificial barrier of a silencer is the final solution for today's flight problems

Early investigation of turbojet noise showed that some improvement could be obtained by making the exhaust nozzle toothed so that the periphery along the line of initial mixing was increased somewhat This technique produced silencing but only in certain frequency ranges and not enough anyway

The real problem and the real difficulty is that the mixing process must be made more gentle This is done now by breaking the primary exhaust stream into a number of smaller jets, each with its own discharge nozzle which is surrounded by ambient air This obtains the sound reduction due to reduction in nozzle cross sectional area, and has the advantage of not reducing the velocity —and therefore the thrust—by too great an amount

This empirical approach has produced a crop of current silencers which work with varying effectiveness and impose varying penalties—some of a magnitude several times the bearable maximum—upon the airplane performance The problem has been further complicated by the need for thrust reversers, which pile on aerodynamic and mechanical problems

Expensive Solution

This first generation of silencer-reversers has cost untold amounts of money to produce General Electric says it will have spent about $2 5 million on silencing when its CJ805 turbojet engine enters airline service Boeing Airplane Co has already spent $12 million and is budgeted to spend $2 million more; this is almost as much as the total cost of development and construction of the first prototype 707 transport Thousands of hours of test time, in wind tunnels, on static stands and in flight, have added a multitude of test points to the data collection on the problem, and it still remains unsolved

The ultimate solution is to design quieter jet engines There is some indication that the turbofan engines now being pushed by General Electric, Pratt & Whitney and Rolls-Royce, will be quieter by a substantial margin than these first-generation of commercial jet engines converted from the high-thrust military units

But the staggering amount of money spent on this device is certainly without parallel in aircraft development Contemplation of it moved one engineer to deep thought recently and he recalled how one company had dealt with a noise problem of its own An old farmer lived and worked off the end of their main runway and had been so doing for the years of piston engined operations In due time, the jets arrived and so did complaints from the farmer. The company made some quick cost estimates of the engineering and test time and development work involved to make engine silencers It was an enormous amount It was also far more money than the old farmer would ever see in his lifetime, or those of his heirs and assigns almost forever.

So the company simply offered the old man an annual sum as continuing compensation He was happy and the complaints stopped

"So you see," said the engineer, "if we had pooled our silencing development money with the amount that all these other firms spent, we could have bought off everybody living within the sound of the airplanes and we'd never have had another complaint."

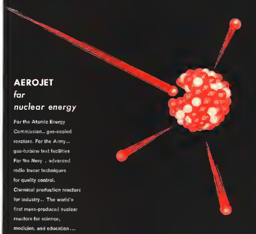
Saab Hopes to Sell J35B in Europe

Geneva—Saab Aircraft Co., Linkoping, Sweden, is reinforcing its export drive in Europe with a more developed version of its Draken fighter series

The new Saab J35B is a modified version of the Saab J35A supersonic jet fighter (AW March 24 p 46)

With a top speed of more than Mach 2 and equipped with Saab's collision-course fire control system and air-to-air guided and unguided missiles the Saab J35B will follow the Saab J35A into squadron service with the Royal Swedish Air Force Initial rate of climb of the J35B is estimated at 50,000 fpm Service ceiling and range will be considerably increased and the aircraft will be capable of carrying heavy ground attack armament.

A more powerful engine will be installed in the export model This powerplant will be a developed version of the Rolls-Royce Avon engine, but the company declines to specify its thrust rating Using a Swedish afterburner, the engine would have to be in the 20,000-lb thrust category to raise the present rate of climb to the estimated figure for the J35B, according to one powerplant expert.



Aviation Week Pilot Report (Part II):

Electra's Turboprops Aid Short Landings

By Richard Sweeney

(This is the second portion of a two part pilot report on the Lockheed Electra turboprop transport The first portion which appeared in last week's Aviation Week, covered walkaround inspection cockpit takeoffs, climbs and flight test work)

Burbank, Calif—No full stalls were done in prototype Lockheed Electra N1881 (Lockheed No 1001), due to test instrumentation aboard However, the turboprop transport was flown into buffet regions to sample flight characteristics and speeds

Gross weight approximated 91,396 lb. with center of gravity at 25.7% mean aerodynamic chord. Altitude varied from 13,000 ft to 10,000 ft

In landing configuration, the aircraft reached initial buffet in straight-ahead path at 95 kt indicated airspeed and exhibited no tendency to fall off on a wing Buffet was not violent, nor did the airplane shake excessively Buffet was allowed to progress approximately 2 to 3 kt before recovery was initiated.

Using approach flaps, 10 deg bank turn to the right gear down, initial buffet was recorded at 120 kt, although the buffet was very mild Acceleration was slightly more than 1G The aircraft was not forced on into the buffet region, the wings were leveled and recovery initiated

In clean configuration initial buffet was reached at 118 kt IAS

In all samples, the aircraft would satisfactorily recover without accelerated stalls if nosedown recovery technique was used. Altitude loss was not excessive from point of initial buffet

Dropping nose to horizon and flying out of stalled condition with power is the preferred recovery technique The aircraft flies out extremely well with power application, and the smoothness of Electra's propulsion system is definitely an asset in this technique

Several flight control boost off investigations were made One was a high rate descent from 24,000 ft to approximately 12,000 ft, in which airspeed was held between 240 and 260 kt IAS, and descent rate approximated 4,000 fpm Control forces were very heavy in this condition, but the aircraft remained fully controllable Standard rate turns to left and right were accomplished during the descent to sample forces and responsiveness Trimout was to almost neutral yoke force in pitch, leaving about 20 lb stick push force required to hold aircraft in desired attitude

GCA With Boost Off

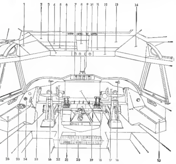
One ground control approach to Lockheed Air Terminal was made in No 1001 with boost off. Radar operator, working with airport surveillance radar only, no precision approach radar, gave steering information and also informed on proper altitudes at strategic points along flight path. From outer marker at Burbank, distance to airport is approximately 11 5 mi, about double that of normal instrument approach tracks.

Radar steers were somewhat excessive in correction angles, and Aviation Week's pilot soon developed the knack of slight undershoots on steering headings given Radar operator, in addition to giving No 1001 GCA advice, also had to work the usual fairly dense traffic over San Fernando Valley, resulting in a somewhat busy operator However, GCA information quality was such that the aircraft could have been landed out of standard minimums

Working boost off GCA, airspeed used was 140 kt, gross weight approximating 88,746 lb, with center of gravity in normal range (26.6% mean aerodynamic chord) Approach configuration was used, gear down, flaps at 80% (approach) setting

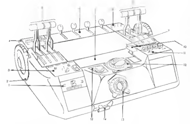
Control forces, while heavy, were not excessive, were considerably lighter than at the higher speeds used in earlier boost off rapid descent Controllability was good, and responsiveness more than adequate Use of trim is much more important in boost off flight, and trimming for near zero forces is normal technique

Aircraft was flown to 200 ft above ground level before missed approach procedure was initiated Again, controllability and response were very good,



1 OVERHEAD LIGHT CONTROL PANEL
2 AIR CONDITIONING CONTROL PANEL
3 LANDING LIGHT CONTROL PANEL
4 AIRFOIL ICE CONTROL PANEL
5 PROPELLER ICE CONTROL PANEL
6 ICE CONTROL LOWER PANEL
7 GLARESHIELD PANEL
8 ENGINE STARTING CONTROL PANEL
9 MAGNETIC COMPASS
10 PROPELLER FEATHER CONTROL PANEL
11 CABIN PRESSURIZATION CONTROL PANEL
12 CABIN AIR COMPRESSOR CONTROL PANEL
13 ELECTRICAL CONTROL PANEL
14 ENGINE TEST OVERHEAD PANEL
15 CO-PILOT'S SIDE CONSOLE
16 EMERGENCY AIR BRAKE HANDLES
17 CO-PILOT'S INSTRUMENT PANEL
18 CENTER INSTRUMENT PANEL
19 CENTER CONTROL PEDESTAL
20 FUEL PUMP CONTROL LEVERS
21 BOOSTER CONTROL LEVERS
22 PILOT'S INSTRUMENT PANEL
23 PARKING BRAKE HANDLE
24 WINDSHIELD WIPER CONTROL
25 NOSE GEAR STEERING WHEEL
26 PILOT'S SIDE CONSOLE

PILOT'S and copilot's controls and control panels are shown in drawing of Electra cockpit.



1	TEMPERATURE DATUM INDICATOR LIGHTS PANEL	9	RADIO CONTROL PANEL
2	ELEVATOR TRIM TAB WHEEL	10	WING FLAP CONTROL LEVER
3	PROPELLER SYNCHRONIZER PANEL	11	OIL COOLER FLAP PANEL
4	RPM SELECTOR PANEL	12	RUDDER TRIM TAB CONTROL
5	POWER LEVERS	13	AILERON TRIM TAB CONTROL
6	FUEL SYSTEM PANEL	14	AUTOMATIC PILOT EMERGENCY DISCONNECT
7	AUTOMATIC PILOT CONTROL PANEL	15	PEDESTAL LIGHT CONTROL PANEL
8	FUEL GOVERNOR OVERSPEED PANEL		

TYPICAL Lockheed Electra cockpit center control pedestal is shown in drawing

and aircraft demonstrated the quality of propulsion system combined with aerodynamic characteristics in the small trim change which resulted when rated power was applied as missed approach procedures were initiated.

Aircraft, held against small trim change, was cleaned up completely as quickly as possible, and airspeed of 200 kt. assumed in the climbout. Aircraft was maneuvered through existing airport traffic which was medium away from the immediate Burbank area and was re-entered into normal traffic pattern.

Control hydraulic boost was restored on entry leg of standard pattern.

Handles Well

Flying the Electra through a missed approach with no boost, through the ground control approach and maneuvering in fairly dense traffic, showed that the aircraft handles well under these circumstances. Control effectiveness throughout the speed regime without hydraulic boost is very good, as is control responsiveness. Aircraft is much easier to fly, boost off, than earlier Lockheed transports which incorporated hydraulic boost controls.

Several Instrument Landing System approaches were made with 1001 in addition to the first flight mentioned earlier. Landings were made out of most of these approaches. One additional night ILS approach was made with the aircraft landed out of the ILS.

The Bendix pilot display was well matched to the Electra's dynamics and contributed to aircraft's overall excellence in instrument landing approaches.

During the first night ILS approach, Aviation Week's pilot had a slight tendency to overcontrol in steering, and stayed consistently high on glide slope. Although the Electra does not have speed brakes (they were eliminated early in the flight test program) altitude control is easier than with conventional piston powered aircraft in that when flight idle power setting is used, the aircraft will slow up significantly, and when power is reapplied, the constant speed turbine advantage is clearly demonstrated since there is no engine acceleration time, power comes in as applied through propeller blade angle change.

The aircraft was held high on glide slope until runway approach lights were in sight, which was not a long distance due to restricted visibility. Power was chopped to drop the aircraft to proper altitude to come over the fence and power reapplied to bring the aircraft through to the flare. The fairly major correction applied close in indicated that Electra margins in performance are significant contributors to the aircraft's high degree of flyability.

Stability of the aircraft when trimmed out onto an ILS approach is very high. Although no high crosswinds were encountered in ILS approaches, two approaches were made wherein turbulence was encountered between the middle marker and the runway, at Ontario International Airport. Allowing the plane to fly through the turbulence without heavy corrections worked out very well, the aircraft required but minor corrections after turbulence was passed.

One simulated engine-out wave-off was performed, in the overwater test area, with 9,000 ft. assumed as ground level. No. 1 (critical) engine was shut down and propeller feathered rather than using negative torque system. Standard square, left hand pattern was flown with turn onto final approach leg made at 700 ft. above simulated ground level. Gross weight at start of run was about 90,974 lb.

During the simulated engine out procedure Aviation Week's pilot accomplished all work alone, i.e., gear and flap handling, power changes.

As would usually be the case in such a situation, airspeed was held somewhat above normal values in late stages of the run. Majority of the pattern was flown at 140 kt., approximately V_s plus 35 kt. for the existing gross weight.

Turn onto final approach heading was made at 140 kt., aircraft was trimmed out in the approach configuration and airspeed bled off slowly. Standard rate descent was made on instruments, the aircraft was put into landing configuration and trimmed out. Go around was initiated at 9,050 ft., and airspeed was 125 kt. indicated.

Small Climb Gradient

Aircraft was accelerated to 130 kt. as takeoff power was applied to three operative engines and gear was raised. Small climb gradient was established and flaps were retracted to takeoff approach setting. With Fowler type flaps sink was negligible since travel between 80% and 100% flap is primarily drag producer.

With approach flap, rated power on operative engines, 140 kt. IAS climb was initiated, yielding 1,000 fpm. climb.

The aircraft was held against trim changes until climb was well established, which was not difficult. Trim changes were minimal since airspeed did not change excessively and with constant speed turbine engines, propeller blade angle absorbs higher power without varying rpm., reducing torque to fairly low level.

Both yaw and pitch trim change stayed at acceptable levels.

Landing techniques with the Electra are completely standard. Usual procedure is to come over the fence about 115 to 120 kt., with power, flare out and cut power, allowing the aircraft to fly onto the ground. Due to the large propeller areas, when power is reduced to flight idle a large drag is created and the aircraft will settle onto the ground nicely.

If over the fence speed is 120 kt., power can be chopped at start of flare, but flare must be completed swiftly and smoothly. At 110 kt. or less, power is used to accomplish a smooth flare onto the ground.

In accomplishing a short landing run, the aircraft's large propellers can be used to very good advantage. Flying on with minimum speed and chopping power, dropping the nose and putting propellers into Beta (reverse) range will result in a very short stop. At maximum landing weight, the aircraft can be stopped very short, and at lighter weights, the aircraft can be stopped within hundreds of feet after touchdown.

Usual buffeting associated with reverse pitch propellers is present in the Electra, requiring the usual care in controls handling on the ground until stop is made or speed is reduced to taxi values.

A quick change from high to low ground idle propeller rpm. also can be used to help stop the aircraft if reverse range is not used on the ground runout.

Landing Capability

Landings accomplished with the Electra were of reasonable quality on the average, and once the proper technique was established as a pattern, and optimum power management ascertained, landings became very easy.

Generally speaking, transport pilots will find little change from the piston engine planes in landing the Electra. Conventional techniques are valid, more than adequate with the turboprop aircraft's efficient propulsion system. When optimized techniques are developed by individual pilots, landings should prove much easier than with heavier piston powered aircraft.

Indicative of the Electra's capabilities at landing, some months ago during flight test and certification program period, propellers on No. 1001 were inadvertently taken into Beta range just when landing flareout was being started. Aircraft sink rate rose to 18 fps., the value used for carrier landings. Landing gear was removed, Magnafluxed, X-rayed, microscoped and Rockwell tested, but was found to be in no way harmed and was perfectly satisfactory for a return to service after the checkout. Primarily, it is reported, the landing was extremely hard, rather surprising to the pilots, but did not become critical even after the severe drop. One piece of skin on the upper right wing was found to have a small crack the day after the incident but the only fix required was a doubler plate, so small it produced no aerodynamic effects.

Flight work in N5509 of Eastern Air Lines was limited to flying ILS approaches to judge the aircraft as a production unit as opposed to the test prototype which had been used in the majority of flight evaluation work.

Layout of cockpit and instrument panel especially, observing the basic T pattern of Civil Air Regulations, was excellent. Collins pilot display in this particular aircraft was encountering some difficulties in leveling of the horizon bar and therefore precluded completely valid judgment of the equipment. Additionally, the aircraft itself, which was on a production test flight to check out fixes for squawks on earlier production flights, still had some rough edges, but despite these, performed in proportion to the prototype.

Aircraft was flown through two ILS runs to just beyond the middle marker, on into a missed approach procedure and standard airline en route climb speed was established for climbout. The aircraft performed very well, but was at fairly light gross weight.

During N5509 takeoff, Aviation Week's pilot rode in the farthest aft seat of the aircraft, to gain an impression of takeoff characteristics from this area. Noise was at a low enough level to permit conversation in normal voice,

acceleration was smooth, and rotation seemed smaller than in piston type aircraft. Climbout and several minutes' flying contributed to an over-all pleasant reaction to the aircraft especially as related to noise levels and vibration

As with any new aircraft, the Electra has undergone some changes and modifications resulting from flight test

One of the first changes was an increase in rudder area by 27%, from 47.16 sq ft to 60 sq ft. Area was added by extending the trailing edge an average of 8 in. up the span

Another change, mentioned earlier, was elimination of speed brakes, which were located on the belly, and worked in conjunction and coordination with flaps. Tests indicated descent rates were adequate to meet design goals and Civil Aeronautics Administration standards without these brakes, and they were removed

Modification Incorporated

One modification which is now being incorporated in production aircraft is a beef-up of the lower wing surface in sections just ahead of rear beam. One maximum speed dive test on one aircraft resulted in unexpectedly high incremental torsion loads which caused minor damage, and two panels just forward of rear beam had shear stability increased by strengthening attachments and adding material to vertical risers

One additional change is to be made on the pilot's control pedestal, in which radio control sections on aft part are to be swung upward to level position from the present downward-angling surface. Change will improve pilot and copilot views of their individual panels and facilitate control handling

Illustrative of Electra's maintainability was the recent Europe and Middle East tour undertaken by No. 4 aircraft. Aircraft was gone from Burbank more than six weeks and carried small-size replacement items and one Quick Engine Change (QEC) package, the powerplant unit

During the tour, a total of 132 separate flights were made, for a total of 149 hr. 30 min flown, covering a distance of approximately 52,000 mi. Breakdown was into 82 demonstration flights in 58 hr. 42 min., and 50 en route flights totaling 90 hr. 48 min

Closest thing to a major repair occurred in Naples, Italy, when an O seal ring in one engine's hot section had to be replaced after an oil leak was noticed at an inspection. Work was accomplished at U. S. Navy base there, was done by plane's crew plus Navy personnel who happened to have a holiday, pitched in to help where they could

Hot end of installed engine was removed, the QEC package removed from plane and O seal ring taken from it, installed on the working engine hot section which then was replaced. QEC package was repacked, replaced in the Electra and the engine was run up. Work was started at 8 a.m. and was completed by 4 p.m.

No special tools were needed or available. QEC was laid on wooden pallet for removal of O ring; a strap sling was hung over Navy hoist truck to remove and replace engine hot section. One other problem arose. A starter shaft sheared, fairly early in the tour. Starter was replaced in less than 1 hr.

Day to day maintenance consisted of opening nacelles, complete visual inspections and standard checkouts, after each flying day, completing all but engine runs of normal preflighting. Engine runups were accomplished next day, prior to start of the day's flying.

Chance Vought Opens Trisonic Wind Tunnel

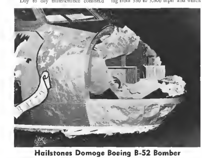
Dallas—Chance Vought Aircraft has started operating a $4 million wind tunnel capable of testing at velocities ranging from 380 to 3,800 mph and which can eventually be expanded to run tests at Mach 10

New blow-down-type tunnel supplements Chance Vought's older subsonic tunnel and is called a trisonic facility because it can test models at subsonic, transonic and supersonic speeds. First test subject scheduled in the hypersonic tunnel was an escape capsule for the Dyna Soar which Vought is designing as part of the Boeing Airplane Co. team

Tunnel will accommodate models with wingspans up to three feet and lengths to four feet. Design work on the facility was started in February 1956 and construction began south of the Chance Vought plant here a year later. Between June and December 1958, 500 test runs were made to check equipment before the tunnel went into regular use

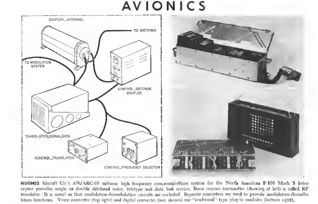
Air for the tunnel is stored in six steel tanks under pressure of 600 psi. Airflow runs through a 14 ft settling chamber to smooth it out, then goes through a variable nozzle into the four foot square test section. Air pumped into the storage tanks is dried and heated to eliminate moisture

After the test run, the air is exhausted through a silencing tower fitted with baffles to cut noise. Tests last only 30 to 40 sec, but only two to four tests can be made in an hour because of time needed to replenish the air tanks



Hailstones Damage Boeing B-52 Bomber

Despite major damage by hailstones described by the crew of this Boeing B-52 jet bomber as the size of baseballs, the Pratt & Whitney J57 turbojet engines continued to put out full power and the aircraft was landed safely at Carswell AFB. Hailstones smashed the windshield and tore the radome away (above). Wing leading edges were hammered flat and considerable metal was ingested by the eight engines. Nacelles were damaged (below) but the aircraft flew for 1½ hr. after hitting the storm, which lasted 47 sec



HUGHES Aircraft Co.'s AN/ARC-68 airborne high frequency communications system for the North American F-108 Mach 3 interceptor provides single or double sideband voice, teletype and data link service. Base receiver-transmitter (drawing at left) is called RF translator. It is novel in that modulation-demodulation circuits are excluded. Separate converters are used to provide modulation-demodulation functions. Voice converter (top right) and digital converter (not shown) use "cordwood" type plug-in modules (bottom right).

F-108 Communication Avionics Unveiled

By Philip J. Klass

St. Petersburg Beach, Fla.—First details on USAF's versatile new AN/ARC-68 high frequency (HF) airborne communications set to be used in North American F-108 and possibly the B-70, were disclosed here at the Second National Conference on Global Communications. Slightly modified version of ARC-68 is being used in the Convair B-58.

The ARC-68, which incorporates a number of new operational and design concepts, is part of the USAF's new AN/URC-15 Strategic Communications System, which also includes the AN/CRC-49 ground based equipment.

System was developed by Hughes Aircraft Co. under sponsorship of Wright Air Development Center's Communication & Navigation Laboratory under code name of "The Lost Chord" (AW May 27, 1957, p. 90).

The ARC-68 marks Hughes' entry into the airborne HF radio communications field in competition with Radio Corporation of America's ARC-21 and ARC-65 airborne HF sets and the ARC-52 produced by Collins Radio.

Air Force desire to use the Hughes ARC-68 reportedly was a major factor in its recent decision to reject North American's choice of Collins Radio as supplier of F-108 Mission & Traffic Control subsystem, in favor of one proposed by International Telephone & Telegraph Co. which will incorporate Hughes ARC-86 (AW Dec. 1, p. 30).

Hughes Aircraft recently has set up a separate operating division to handle its growing activities in the communications field.

One of the basic objectives of the ARC-68 program was to develop a set which had the versatility and growth potential to accommodate a wide variety of different modulation techniques, ranging from voice to data link, according to George H. Scheer of WADC's Communication & Navigation Laboratory. The ARC-68 provides the following different operating modes:

- **Amplitude modulation** (AM) voice.
- **Single sideband** (SSB) voice, either suppressed carrier or with carrier—the latter to permit compatibility with existing AM equipment.
- **Double sideband,** suppressed carrier. Two sidebands can be modulated by single signal, or each by a separate signal.
- **Teletype,** for ground-to-air or air-to-ground service at rates up to 65 words per minute. Selective calling provision enables one station to communicate with any single station or group of stations.

On-line cryptographic capability can also be included.

- **Data link,** a digital communication service similar to that now provided at ultra high frequency (UHF), employs advanced modulation technique involving pulse phase changing to permit operation in the HF band.

The ARC-68 covers the 2 to 36 mc. band in one kilocycle steps, providing 34,000 possible frequency selections.

In keeping with WADC's design objective, the ARC-68 departs from conventional practice by excluding modulation and demodulation circuits from its basic transmitter-receiver, which is called an "RF translator," L. A. Brite reported at the Globe Com Conference. All inputs to, and outputs from, the RF translator are low-level signals at a 1,750 kc. intermediate frequency instead of at audio frequencies as in conventional HF sets.

Modulation and demodulation circuits are contained in separate devices, called "converters," each of which is tailored to its specific mission. For example, Hughes has developed one converter for voice modulation, another for digital (pulse) modulation for data link use.

Evaporative-gravity (Ev-Grav) cooling technique, developed by Raytheon and first described by AVIATION WEEK (July 29, 1957, p. 74), was credited by Hughes' E. M. Boardman with making possible the extremely compact power amplifier in the ARC-68 RF translator. Unit generates approximately 1,600 watts of heat in volume of only 370 cu. in., Boardman reported.

In its simplest form, Ev-Grav cooling employs air-tight enclosure for avionic assembly which is completely immersed in suitable fluorochemical liquid, leaving small gap between level of liquid and top of enclosure. Avionic heat vaporizes liquid, carrying heat off in form of vapor which comes into contact with top of enclosure which is cooled by ram air or other external means. Hot vapor transfers heat to enclosure, condenses and drops back into the bath.

Sophisticated Version

This simple technique cannot be used in aircraft that fly in a non-level attitude for extended periods. For this reason, Hughes developed a more sophisticated enclosure that includes an expansion chamber, passive valving and motor-driven pump.

Boardman said that Ev-Grav technique is about 100 times more efficient than simple air convection for transferring heat generated by hot-spot components within the power amplifier. With this technique, many components can be safely operated considerably above their normal ratings, he said. For instance, a one-watt resistor can be safely operated at 25 watts, while diodes and tubes can be similarly up-rated.

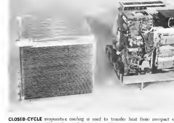
Present fluorochemicals are heavy, Boardman conceded, but their high cooling efficiency still permits sizable weight and space saving over pressurized air cooling. Several lighter weight fluorochemicals are now being developed which look promising, Boardman said. Hughes also is investigating the possibility of vapor cooling and possibility of shifting location of low voltage, temperature-passive components outside the liquid bath to reduce amount of fluorochemical required for immersion, Boardman reported.

'Cordwood' Construction

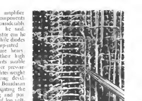
The ARC-68 digital converter, like a digital computer, is constructed from a few widely used basic circuits, such as flip-flops, which lend themselves to compact construction and automatic assembly.

Hughes employs what it calls "cordwood" construction for most of the digital plug-in modules. This consists of two etched conductor boards with components sandwiched axially between. The result is extremely compact, lightweight construction, with increased rigidity provided by axial-leaded components serving as structural members.

Cordwood modules containing 60 components can be assembled by hand in 12 to 15 min. using simple tooling. However, Boardman disclosed that Hughes has demonstrated feasibility of mechanized assembly, using simple machine which can reduce fabrication time by factor of 50 to 60.



CLOSED-CYCLE evaporative cooling is used to transfer heat from compact one-kilowatt power amplifier to its enclosure (left) by immersing components in fluorochemical.



WIRE WRAP, used instead of soldering to make hundreds of interconnections, permits more compact construction.

Interconnecting all of the cordwood modules on the baseboard into which they plug requires some 4,000 wires for the ARC-68 digital converter. The modules are so closely stacked that this presents a difficult soldering job. For this reason, Hughes has turned to wire wrap technique originally developed by Bell Telephone Laboratories (AW March 8, 1954, p. 43).

The ARC-68 is believed to be the first U. S. airborne equipment slated for production to use the wire-wrap technique. British have shown an interest in wire-wrap for airborne use.

Insulation Buffer

In adapting wire wrap to airborne use, Hughes has made one change in the original technique. Instead of stripping insulation off all of the turns of wire wrapped around the terminal, Hughes leaves insulation on first turn which acts as buffer to damp out stresses imposed by vehicle vibration.

Individual wire wrap operations can be accomplished by means of a small hand "gun" produced by Keller Tool Division of Gardner-Denver Co. However, the company has developed a new automatic wire wrap machine for Hughes which can be operated directly from punched tape or by manual keyboard for single trial runs. The machine automatically cuts wire to the desired length, strips insulation off each end, forms wire to desired shape and wraps both ends around appropriate terminals.

Up to 10,000 wires can be placed on a 20 x 20 in. terminal board, Keller Tool says, a density which would be difficult to achieve if each wire had to be soldered.

Interesting aspect of the process is

HUGHES leaves insulation on initial turn of wire wrap to provide buffer which isolates airplane vibration in flight

that Hughes can go directly from the Boolean algebra equations prepared by its design engineers to wired terminal boards without ever preparing a schematic or wiring diagram. A technician works from original equation to prepare a chart from which another operator prepares punched tape that controls the wire wrap machine.

RF Translator

The ARC-68 RF translator, as described by C. S. Root of Hughes at Globe-Com, consists of the following components:

- Control unit, which enables pilot to instantly select any one of 20 preset channels. This is similar to control provided for existing ARC-21.
- **Frequency selector** which enables pilot to select any one of the 34,000 available channels by rotating five selector dials.
- **Signal data translator,** which includes frequency synthesizer, combination receiver and driver, a one kilowatt linear power amplifier and low voltage power supply.
- **Antenna coupler and control,** developed by Remington Rand Univac, which automatically matches impedance of aircraft antenna to power amplifier.

Local oscillator (VFO) of the receiver-driver is automatically tuned to any one of the 34,000 frequencies with an accuracy of one part in 10 million, Root reported. Binary coded signal from the frequency selector causes a digital switch in the synthesizer to select appropriate 1 mc., 100 kc., 10 kc. and 1 kc. harmonics from a 1 mc. frequency standard oscillator. These are applied to the first, second, third and fourth mixers, respectively, which produces a 100 kc. intermediate frequency output when the local oscillator is properly tuned to same frequency. A frequency and phase-lock discriminator circuit automatically tunes the local oscillator to 100 kc. with an accuracy of one part in 10 million, Root said.

In the receiver-driver portion of the signal data translator, an incoming 2 to 36 mc. signal passes through a receiver RF amplifier, a transmit-receive RF amplifier, a receiver mixer where it is heterodyned to produce a 1,750 kc. intermediate frequency, then through a broadband IF amplifier. The 1,750 kc. signal then goes out to one or more of the separate converter units for demodulation.

For transmit sequence, the 1,750 kc. input signal from converter passes through a transmit IF amplifier, a transmit balanced mixer where it is heterodyned to produce the RF signal, through the transmit-receive RF amplifier, the transmit output amplifier and finally to the power amplifier. A 1,750 kc. "tune-up oscillator" is included to provide a continuous-wave carrier to keep transmitter precisely tuned for modulation systems which provide no carrier, Root said.

The complete signal data translator

ARC-68 antenna coupler, developed by Remington Rand Univac, maintains proper antenna impedance match

weighs 75 lb., measures approximately 9¾ x 10¼ x 20 in.

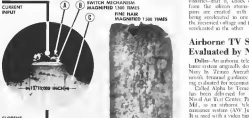
The converter which provides voice modulation-demodulation function for the ARC-68 was described at Globe Com by R. J. Kircher of Hughes.

One interesting operational feature is the ability to transmit two sidebands simultaneously with each carrying different messages. This could permit, for example, two crew members to talk simultaneously with two different people on the ground during a single brief transmission.

Crystal filters are used in the converter to select the upper or lower sideband.

When dual channel single sideband operation is employed, the output of the two filters is combined, with the 1,750 kc. carrier suppressed more than 40 db., Kircher reported. The 1,750 kc. carrier used in the converter is derived from the same 1 mc. quartz crystal frequency standard used by the RT translator.

Complete voice converter in a shock mounted package, including the associated control box, weighs approximately 16 lb.



SEMICONDUCTOR switch is said to operate in about 0.05 millimicroseconds. Increase in voltage at point A initiates avalanche effect through junction B to base material C. Device has been developed by Sperry Semiconductor Division of Sperry Rand Corp.

High-Speed Switch Device Tested

A new semiconductor switch that utilizes the avalanche effect to achieve switching speeds said to be about 100 times faster than those attainable with the best such devices available today has been announced by the Sperry Semiconductor Division of the Sperry Rand Corp. Switching time of the device has been calculated to be about 0.05 millimicroseconds which is twice as fast as can be measured with the most advanced laboratory instruments.

Only a few hundred of the devices have been produced on a pilot manufacturing line to date, but Sperry scientists believe them to be promising enough to constitute a basic building block for improving accuracy, speed and range in navigation and guidance of missiles and space vehicles. Their application in very high speed computers conceivably could compress one continuous year of computing time with present computers to only three days, they say.

The device which was developed with the assistance of the Univac Division of Remington Rand has already been employed in new computer logic circuits operating at 100 mc. clock speeds, where they were said to operate very much faster than any of the computer's other components.

The semiconductor alloy junction comprising the working element of the switch is formed by fusing a small flake of aluminum to a silicon base. The avalanche effect takes place entirely within the junction layer and operation of the switch depends on controlling the conditions for penetration of the lattice of the junction atoms and knocking planetary electrons from the atoms' shells.

The junction layer blocks the flow of current until triggered by a "bit" of computer information in the form of a voltage pulse. The increase in voltage accelerates one or more of the electrons to speeds sufficient to knock new electrons out of the atomic shells. These in turn accelerate and knock more electrons free. Each electron creates a chain reaction or "microplasma" which almost instantly spreads throughout the layer and carries current across the junction, turning the switch "on."

A decrease in voltage immediately reduces the speed of the electrons so that they no longer free other electrons. The current carrying plasma is swept out of the layer and current flow ceases, returning the switch to the "off" condition.

Actually, as the electrons and holes that comprise the carriers ionize secondaries—that is, knock electrons free from the silicon atoms—electron-hole pairs are created with the electron being accelerated in one direction by the increased voltage and the hole being accelerated in the other.

Airborne TV System Evaluated by Navy

Dallas—An airborne television surveillance system originally designed for the Navy by Temco Aircraft Corp. as a missile terminal guidance system is being evaluated for reconnaissance use.

Called Alpha by Temco, the system has been delivered for evaluation at Naval Air Test Center, Patuxent River, Md., as an airborne television reconnaissance system (AW June 9, p. 29). It is used with a video tape recorder developed by Mincom, a division of Minnesota Mining & Manufacturing Co. Recorder permits review of data without the trouble of developing film.

Used as a reconnaissance system, Alpha is housed in a pod slung under an aircraft wing. Transmitting component is 8¼ in. in diameter and 105 in. long. Temco said that one of the units has run 1,000 hr. in laboratory tests.

When used for terminal guidance, Alpha sends an image of the terrain to a controller. As the weapon nears its target its course is guided by radio signals transmitted by the controller watching a television receiver in his remote control station.

Microwave Polarimeter Technique Developed

Simple microwave polarimeter technique which permits instantaneous measurement of polarization characteristics of electromagnetic wave has been developed by Naval Research Laboratory.

An 11-page report describing technique, identified PB 151111, is available for 50 cents from Office of Technical Services, Commerce Dept., Washington 25, D. C. Also available, a 19-page report on dielectric-filled waveguide development identified PB 151213, priced at 75 cents.

FLUX valve (direction sensing device) is mounted on surveyor's tripod at right.

Electronic Calibration System Reduces Compass Heading Error

Great Neck, N. Y.—Electronic compass calibration system that can reduce magnetic heading errors to 1/10 deg. has been tested on a missile and several jet powered aircraft by Sperry Gyroscope Co.

New system, the company said, can eliminate present practice of physically rotating the aircraft around a compass rose painted, or installed, on a ramp which reportedly makes it difficult to reduce heading errors to less than 1 deg. Electronic equipment involved weighs about 90 lb.

Sperry said the electronic system makes it possible for two persons to calibrate a compass system in 2.3 hr. (AW Aug. 6, 1956, p. 303). Present methods involve up to five crewmen working up to 8 hr.

In effect, the system allows a line maintenance man to rotate the earth's magnetic field around a parked aircraft for precise check of compass accuracy. System was developed for U. S. Air Force under sponsorship of Wright Air Development Center.

Sperry device has been used to calibrate the compass system of the Northrop Snark surface-to-surface missile and on aircraft including Boeing's B-52, KC-135 and B-47, the Convair F-102 and the Martin B-66.

System works this way:

- **Direction sensing device**, called a flux valve, is placed in small turntable mounted on a surveyor's tripod to align valve with the earth's magnetic north and to determine necessary electric currents needed to cancel out the natural local magnetic field. Valve then is reinstalled in the aircraft and aligned optically.
- **Electrical console**, operated by crewman in the cockpit, is connected by cable to the compass system. Operator then switches the console to each of 24 magnetic headings (each 15 deg. of a circle), console provides voltages and resistances necessary to artificially change magnetic headings. Compass errors are noted by a console meter.
- **Field monitor**, a transit modified to include a direction sensor, is used throughout the procedure to determine direction of the magnetic field about the aircraft and to measure any field changes that occur during the actual calibration.

CONSOLE changes headings artificially.

FILTER CENTER

(Following items are based on papers presented at recent Second National Conference on Global Communications held at St. Petersburg Beach, Fla.)

▶ **Novel UHF Receiver**—General Electric has developed suppressed carrier double-sideband receiver, AN/GRC-88 (XW-1) which operates in ultra high frequency (UHF) band eliminating Doppler shift problems encountered with suppressed carrier single sideband. Developed under Rome Air Development Center sponsorship, the GRC-88 uses synchronous detection principles developed earlier by GE for HF band. Application of technique to UHF band opens a new door to application of phase-shift telemetry for missiles and satellites and more dependable voice or data link air-to-air and air-to-ground communications for high-speed aircraft and manned orbiting vehicles, according to Robert H. Wood and William P. Whiland, co-authors of the paper.

▶ **New Obstacle-Gain Data**—Recent tests have disclosed that up to 55 db. gain can be obtained in mountainous area propagation over smooth earth paths in the 50 to 500 mc. band through use of obstacle or knife-edge diffraction principle, it was reported in paper jointly authored by Raymond F. Lacy, Chester E. Sharp, Army Signal Corps, and Samuel R. Bradshaw, Motorola. Interest in the long-known phenomena was spurred by experience in mountainous areas of Korea where radio stations whose antennas were located contrary to standard practice actually achieved far superior range and reliability. Recent tests conducted in mountains of California show the obstacle gain can be obtained over wide frequency spectrum, from 50 to 8,500 mc., as long as diffraction angle is less than six degrees, authors reported.

▶ **Meteor Burst Speed-Up Urged**—Recent meteor burst communications tests, in which teletype characters were transmitted over 800 mi. distance, suggest that data can be transmitted at 80 times normal rate, compared to speed-up factors of 20 to 30 used in early meteor burst systems, according to Robert J. Carpenter and Gerard R. Ochs, National Bureau of Standards. Using speedup factor of 40, NBS tests showed daily average channel capacity of about 40 words per minute with

Jupiter Guidance

Configurations of major elements of inertial guidance system for Jupiter intermediate range ballistic missile are shown by full scale classroom training models produced by Ford Instrument Division of Sperry Rand which manufactures the system. Shown (l to r) lateral guidance computer, inverter-regulator, servo loop amplifier, programmer, control computer, slant range computer and gyro-stabilized platform. Computers are of analog type; stabilized platform employs air bearing gyros. Jupiter guidance is an outgrowth of a system originally developed by Army's Redstone Arsenal for use in the Redstone missile.

character error rate of about 0.0035. With improved control system for starting and stopping transmission, NBS scientists believe speed-up of 80:1 is feasible. Use of split-beam antenna pattern, NBS tests indicate, is superior to single-beam pattern because it can observe more usable meteor trails and also increase the signal to background noise ratio.

▶ Multipath Protection Technique—Promising technique for minimizing multipath distortion in meteor burst communications was described by Thomas G. Knight, Rome Air Development Center. Technique uses synchronous RF coding system in which transmitted bits are spread out in both frequency and time in a pattern such that multipath distortion on a particular frequency is allowed to dissipate before that particular frequency slot is used again. In the meantime, other frequency time slots are being used. Only penalty is need for greater bandwidth which does not appear severe because of high signal-to-noise ratios available with meteor burst, Knight said.

▶ Big Turn-Out—Close to 1,000 persons attended the Global Communications Conference despite transportation difficulties resulting from Eastern Air Lines strike. Next Global Conference is tentatively scheduled for summer of 1960 at San Francisco.

▶ Jam-Resistant Multiplexer—The AN/TCC-17 universal multiplex equipment being developed by Lenkurt Electric Co. for Air Force, will be designed to operate without synchronization with other terminal station in certain tactical situations or where it is being subjected to enemy jamming, it was reported in paper by David A. Bone, Rome Air Development Center and Norman N. Epstein of Lenkurt. The TCC-17, which will provide for 600 channels and be transistorized, is expected to find extensive use in USAF's 456 L global communications system.

Expansions, Changes In Avionics Industry

Spectracoat, Inc., is name of new company in San Francisco area which will specialize in vacuum deposition of extremely thin films of metallic and non-conducting materials. Company is headed by John R. Jennings, with Albert A. Kusch, Jr., as production manager. Company's address: 248 Harbor Blvd., Belmont, Calif.

Other recently announced expansions, changes in the avionics field include:

- **Motorola** is building new 7,000 sq. ft. flight test facility at Riverside (Calif.) Municipal Airport, near its Systems Research Laboratory.
- **Fairchild Semiconductor Corp.** will build new 65,000 sq. ft. manufacturing plant in Mountain View, Calif., near its present 20,000 ft. facility at Palo Alto. When new plant is completed in May, Palo Alto facility will be devoted to research and development.
- **System Corp.** has moved to new 15,000 sq. ft. plant at 950 Galindo St., Concord, Calif.
- **Standard Electromagnetics, Inc.** has moved into new 20,000 sq. ft. plant at Walkersville, Md.
- **Electrosolids Corp.** has moved into new plant at 13745 Saticoy, Panorama City, Calif.
- **Magnetic Amplifiers, Inc.**, New York City, has acquired new building which increases company's manufacturing space by 40%, bringing total to 35,000 sq. ft. Main offices are at 632 Tinton Ave.

Glass Used in Printed Circuit Production

Photosensitive glass is processed in the production of multiple printed circuit boards at a newly opened plant of the Corning Glass Works in Bradford, Pa. Sensitized glass is placed in acid bath where white areas are leached out. Plant also will manufacture glass electronic components such as resistors and capacitors.

NEW AVIATION PRODUCTS

Tacan Simulator

Portable test instrument, designed to test airborne Tacan or DMET equipment, generates a standard signal on any two of the 126 Tacan channels.

Simulator, designated HLI 119, permits range and bearing checks, coding and decoding and operating frequency

checks, and enables the user to measure peak power and receiver sensitivity. Instrument, measuring 8¾ x 12 x 18½ in. and weighing approximately 35 lb., can function as a laboratory signal source or as a go, no-go checkout device on the flight line.

Hoffman Laboratories Division, 3740 Grand Ave., Los Angeles 7, Calif.

Aircraft Oil

Detergent-dispersant for reciprocating aircraft engines is said to reduce oil consumption, cut wear and keep engines clean.

Aeroshell Oil W is described as a non-ash detergent-dispersant oil for both large and small piston engine aircraft and helicopters. Produced in Grades 80 and 100 viscosities, the oil is said to have multi-viscosity characteristics, eliminating the need for seasonal grade changes.

Shell Oil Co., 50 W. 50th St., New York 20, N. Y.

Hot-Cold Gas Servo

Gas servo for high temperature and radiation environments is designed for operation near rocket engines, in re-entry devices, high speed aircraft and in areas of high nuclear radiation.

Unit, a force servo with position and velocity feedback, can be used with a solid propellant hot gas or stored cold gas energy source. Advantages claimed for the servo include: high frequency response through pressure-type control, electrically controlled damping, adjustable stiffness and accuracy characteristics without change in hardware, poppet valves which minimize leakage and sensitivity to contaminants, and symmet-

rical design that tends to lessen thermal shock problems.

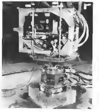
General Electric Co.'s Aircraft Accessory Turbine Dept., Lynn, Mass.

Ejection Seat Simulator

Mobile training unit provides pilots of Convair F-106 jet interceptors with emergency escape procedure training.

Trainer, built to Convair specifications, permits training in functional operation only. Pilot's seat rises 1 ft. to simulate ejection. Air Defense Command will airlift 16 ejection seat simulators to its interceptor bases. Simulator, in addition to training pilots, may be used to train ground crews in ejection seat maintenance.

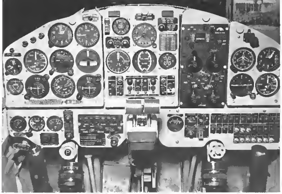
Horkey-Moore Associates, Torrance, Calif.



Vibration Tester

High force vibration tester is designed to test components of high Mach aircraft and space vehicles at North American Aviation, Inc. Model W-2000 "Hydrashaker" is an electronically controlled, hydraulically driven unit capable of blocked force outputs to 24,000 lb. and 2,000 cps.

Wyle Manufacturing Corp., El Segundo, Calif.



MS 760 cockpit. Pilot's power controls plus gear drive brake and flap switches, are located on left console (out of sight).

Aviation Week Pilot Report:

MS 760 Shows Business Plane Promise

By Robert I. Stanfield

CRATED ground handling equipment tools and spares are included in the basic price of the MS 760. Items include dollies rigging fixtures slings tow bar hoists, extra tires and tubes, wrenches, etc. Beech stocks engines and spare parts

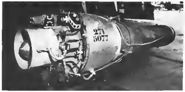
New York—Transition in Beech Aircraft's pressurized 400-mph. plus Morane-Saulnier 760 four-place executive twin-jet aircraft will pose few problems for business-commercial pilots a flight evaluation by AVIATION WEEK indicated. The compact and fast French-built airplane has the control feel of a light to medium piston engine twin performance-wise there is no comparison except for approach speeds slow-flight characteristics and stall docility.

Designed and built in France the airplane is marketed in North America through Beech (AW May 9, 1955, p 22). Basic price is $210,000, including ground handling equipment, tools, spares, pilot and mechanic check-out, and delivery.

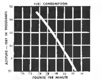
MS 760 is powered by two Turbomeca Marbore 2C jet engines with maximum continuous ratings of 880 lb. static thrust each (22,600 rpm.) at sea level. Dry weight of each is 344 lb. Engines have a one-stage centrifugal compressor, one-stage turbine, centrifugal injection combustion chamber, idling speed of 6,000 rpm starter.

Empty weight of the MS 760 is only

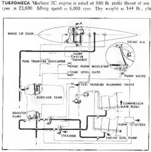
BEECH marketed MS 760 400-mph plus twin jet has a span of 33 ft 3 in. Length is 32 ft 11 in. Wing area is 193.9 sq. ft. Four place, with tip tanks full, wing loading is 39.8 lb./sq./ft. Maximum gross weight is 7,500 lb. Maximum range is 820 naut. mi.



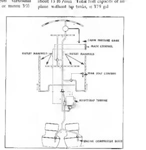
TURBOMECA Marbore 2C engine is rated at 880 lb. static thrust at sea level. Maximum rpm. is 22,600. Idling speed is 6,000 rpm. Dry weight is 344 lb., plus or minus 3%.



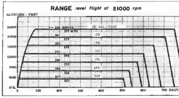
FUEL consumption at 23,000 ft. averages about 13 lb./min. Total fuel capacity of airplane without tip tanks, is 375 gal.



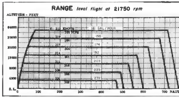
FUEL-USE sequence of the French-built twin-jet airplane is entirely automatic. Pilot needs only to monitor fuel usage during flight.



AIR pressure is supplied by a bleed on each engine compressor. At 16,000 ft. cabin pressure holds to 6,500 ft.



RANGE charts include climb at 22,600 rpm and economical descent (no reserve)



4,280 lb with equipment Current maximum gross weight, with tip tanks, is 7,500 lb Civil Aeronautics Administration may boost this figure by 100 lb

Total of 375 gal of fuel (JP 1 or JP 4) is contained in a 251-gal fuselage tank and two 62-gal wing tip tanks Maximum range is 820 naut mi Service ceiling is 32,800 ft CAA limit ceiling is 25,000 ft

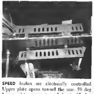
Overhaul period of current engines is 300 hr CAA has increased this to 400 hr in upcoming production aircraft

By comparison the French have set 500 hr for overhaul If no jet fuel is available, airplane can operate on 80 or 100/130 octane gasoline for 50 hr of the current 300 hr period, according to Beech

MS 760 Performance

Key features evidenced during Aviation Week flight evaluation included

- **Small field adaptability** At takeoff gross weight of about 6,020 lb, into a 12 kt wind MS 760 flew itself off at 85 kt within 2,000 ft. Normal 100 kt approach, full flaps (55 deg), resulted in touchdown at 80 kt and landing roll of less than 2,000 ft.
- **Rate of climb** At full throttle—22,600 rpm—the airplane ascended initially at 4,500 fpm Indicated airspeed in the climb was 215 kt Tailpipe temperature was 600C At 7,000 ft, the rate of climb was 3,000 fpm; at 15,000 ft, 2,000 fpm
- **Cruise and single-engine.** At 16,000 ft pulling 21,500 rpm the twin-jet indicated 265 kt for true air speed (TAS) of 343 kt or 395 mph With feet off the rudder pedals the left engine was cut off There was practically no yaw With no increase in power, airspeed slowly dropped off finally to hold at 180 kt indicated for TAS of 232 kt or 267 mph
- **Flight comfort** This is a quiet, comfortable airplane with no vibration apparent At cruise the sound was similar to that of a sailplane swishing through the air Cabin is pressurized and air conditioned by hot air bled from engine compressors Cabin pressure equals outside pressure from zero up to 6,500 ft holds to latter figure to an altitude of 16,000 ft Above 16,000 ft, the cabin pressure equals outside pressure plus 3 5 psi (constant differential pressure)



SPEED brakes are electrically controlled Upper plate opens toward the rear 59 deg Lower plate opens toward front, 65 deg

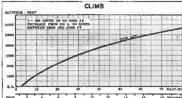
The airplane flown by Aviation Week pilot was N84J, No 6 off the Morane Saulnier production line Up to 20 have now been rolled out at the French plant Accompanying this pilot was Tom Gillespie, sales engineer for this Beech project and one passenger

Clean looking airplane sits close to the ground, maximum height to top of vertical stabilizer being 8.5 ft Tail unit is T shaped, horizontal stabilizer being attached to top of vertical stabilizer Rudder is of standard construction with thick, U-shaped trailing edge It is statically balanced by a metal weight attached in front of the upper hinge bearing and moving through the vertical stabilizer

Wing is made up of two outer panels,

REAR fuselage of the MS 760 is demounted by removing six bolts Work time to detach tail is approximately 15 min. Demounting exposes complete engine installation.

ACCESS hole in forward section of fuselage also permits limited engine maintenance



CLIMB chart for MS 760 at maximum gross weight of 7,500 lb Rate of climb varies from 2,400 fpm at sea level, at 230 kt IAS, to 1,300 fpm at 15,000 ft at 200 kt.

each attached to a center section constructed integrally with the fuselage. The outer panel has a single spar to carry bending loads and a torque box between the main spar and the rear spar The rear spar does not carry bending; merely closes the torque box Each panel is attached to the fuselage by three bolts (two on front spar, one on rear spar) and one pin (at leading edge)

Four place, with tip tanks full, wing loading is 39.8 lb./sq./ft With tip tanks empty, wing loading is 36.6 lb./sq./ft.

The static balance of the ailerons, on the wing trailing edge, is provided by a metal weight attached to the nose of the aerodynamic balance, located in front of the hinge line A fabric seal is attached to the balance nose and to the rear wing spar The nose balance moves between the upper and lower skins of the rear part of the wing Only the left aileron has a trim tab

Elevator also is of standard construction It is statically balanced by metal weights attached at the front of the aerodynamic horn balance The horizontal stabilizer angle is adjustable in flight There is no elevator trim tab.

Canopy of the MS 760 is constructed of high impact resistant Plexiglas Access to the cockpit is by a small entrance ladder. Canopy cannot be closed until entry ladder is stowed (microswitch in closing circuit being controlled by the ladder).

The cockpit is plush roomy and comfortable Leather-covered front and rear seats are fixed Back of the front seat is detachable. Back of the rear seat is made up of the rear pressure bulkhead The seats are neither adjustable nor ejectable

Baggage Space

Baggage may be carried under rear seat and in fuselage compartment aft of the cabin Former embraces area 36 in. wide by 25 in. long by 9 in. deep Rear compartment, which will be extended to the next bay in future deliveries, presently takes in an area of 22 in. wide by 23 in. long by 15 in. deep

Opening and closing control of the canopy—made up of a fixed windshield and a sliding canopy cover which opens toward the rear—is electromechanical Manual control permits opening in case of electrical failure Exterior folding handle opens and closes the canopy when the airplane is parked The windshield is equipped with adjustable blue sun shades, canopy has adjustable curtains on side windows.

Instrument panel consists of a left and right flight panel, and centered engine panel Radio-navigation controls are located just to the right of the engine instruments and on the lower panel adjoining center power controls

Flight instruments include accelerometer, radio-compass indicator, clock, airspeed, artificial horizon, rate of climb, triple indicator giving aileron tab, horizontal stabilizer and flap position, altimeter, gyromagnetic compass and turn indicator.

Engine instruments include jettison valve control, fuel gage and flow meter, tachometer, tailpipe temperature indicator, oil pressure switch, engine fire warning light.

Left lower panel seats gear indicator, cabin pressure indicator and pressurization warning light, temperature gage, radio switch box, oxygen control and cabin ventilation. Right lower panel contains circuit breakers, battery switch, generator switch and warning light, fuse box

Gear Switches

Landing gear, dive brakes and flaps switches are located on console on left side of cockpit, adjoining pilot's seat

Flight controls are dual, embracing fighter-type sticks for longitudinal and lateral control, and adjustable rudder pedals. Linkage is rigid type, with push rods, torque shafts and links. Switch on top of left stick controls longitudinal and lateral trim Rudder pedals are adjusted via a small wheel located below instrument panel at the center of each set of pedals Right hand rudder pedals and stick can be disconnected.

Dual power controls are located on quadrant centered below engine instruments and on console on left side of cockpit

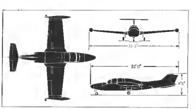
Normal starting is made on the airplane's battery Turbine starting procedures are relatively simple and quick. With electric boosters on, the left starter was engaged until the tachometer showed 1,000 rpm Ignition (lighting button) was squeezed and fuel cock advanced all in one motion and held until tail pipe temperature was indicated The starter was cut at 5,000 rpm and ignition released, same procedure was used for right engine.

Taxi and Takeoff

Nose wheel steering is linked to rudders, and the airplane moved along at a good clip at 11,000 rpm Before takeoff, the nose was trimmed a shade high and 17 deg of flaps lowered

With three of us aboard, and about 150 gal. of JP-4 in main tank, the airplane, with equipment and light baggage, grossed out at about 6,020 lb. Sea level pressure was 29.90 Outside air temperature was 47F Field elevation at MacArthur Field is 98 ft Wind was from the west-northwest at 12 kt

MS 760 took the runway immediately, no warm up being necessary With brakes locked, throttles were advanced



THREE-VIEW drawing accentuates clean lines of MS 760 Length almost equals width

Beech MS 760 Specifications and Data

SPECIFICATIONS

Wing span	33 ft. 3 in
Length	32 ft. 11 in
Height	8 ft 6 in
Wing area	193.9 sq ft
Vertical stabilizer surface	18.42 sq ft
Horizontal stabilizer surface	32.11 sq ft
Empty weight (as equipped)	4,280 lb
Maximum gross weight	7,500 lb
Tricycle gear	
Track	7 ft. 11 in.
Wheel base	13 ft 2 in
Main wheels	19 in x 7 in
Nose wheel	14 in x 6 in.
Fuel (total of 375 gal.)	
Fuselage tank	251 gal
Tip tanks	124 gal
Oil capacity	3.7 gal

Powerplant two Turbomeca Marbore 2C jet engines with maximum continuous rating of 880 lb static thrust each (22,600 rpm.) at sea level

PERFORMANCE

Initial gross weight	7,500 lb
Maximum speed	380 kt (410 mph.)
Service ceiling	32,800 ft
CAA limit ceiling	25,000 ft
Time to climb to 25,000 ft	22.5 min
Rate of climb (22,600 rpm.)	
Sea level (at 230 kt IAS)	2,400 fpm.
15,000 ft (at 200 kt IAS)	1,300 fpm.
Rate of climb, single-engine (22,600 rpm.)	
Sea level	600 fpm
8,500 ft	100 fpm
Stall speed (clean)	97 kt
Stall speed (dive brakes extended, flaps 55 deg.)	83 kt
Maximum range	820 naut. mi
Intermediate range (30 min reserve)	675 naut mi
Endurance	2 hr. 45 min.
Takeoff ground run (sea level no wind)	2,460 ft
Landing ground run (sea level no wind)	2,115 ft.

to the stop and gages checked. Readings were in the green, and the tachometer indicated 22,600 rpm. Brakes were released and the airplane moved swiftly down the runway.

Rudder travel is 21 deg. left or right. Control was effective at 60 kt., at 85 kt. nose wheel was raised and we were airborne, in about 2,000 ft. Gear retraction takes about 15 sec. Airspeed built up quickly past minimum control speed of 110 kt. Flaps were raised at 140 kt. with little sink. Airplane was just beyond boundary markers when normal climb was initiated. Speed was 215 kt. Rate of climb, at full throttle, 4,500 fpm. Tail pipe temp was 600C.

The MS 760 has a firm, smooth response to control pressures and is not an overly sensitive airplane. The airplane quickly trimmed up via switch button on the left control stick for hands-off ascent. We were quite comfortable in the pressurized and air-conditioned cabin.

Climbing through 7,000 ft. our rate of ascent was 3,000 fpm. At 15,000 ft. the rate of climb was 2,000 fpm. Visibility was good during ascent. Airplane was leveled off at 16,000 ft. and crossed Mitchell AFB, 22 naut. mi. west of takeoff, at this altitude.

Throttles at cruising altitude were reduced until rpm. indicated 21,500, slightly above normal cruise rpm of 21,000. Outside air temperature was −13C. Tail pipe temperature was 530C. Airspeed indicated 265 kt. for a true reading of 343 kt. or 395 mph. Cabin pressure up to 16,500 ft. indicated 7,000 ft.

In case of pressurization failure, an oxygen bottle of 264 gal. (1.73 gal. at 2,175.6 psi.) is located in fuselage nose, valve of which is controlled by a handle at right front seat. The bottle is connected to four oxygen regulators; two at the front seat and two at the rear seat. Demand type regulators are connected by flexible tubing to Ulmer 16 mm. oxygen masks.

Aileron control and stability of the MS 760 were excellent during turns at varying speeds and rates of bank. Aileron travel is 15 deg. 20 min. up, and 7 deg. 40 min. down.

Acceleration Time

In flight, speed with which power controls (throttles) are moved is not limited due to acceleration control on engine. Acceleration time varies with speed and altitude. Time to accelerate from 17,000 rpm. to 22,600 rpm., at 4,900 ft. averages 5 sec. At 13,000 ft. time averages 8 sec., and at 23,000 ft. average is about 10 sec.

Authorized maximum speed of the MS 760 is limited to 350 kt., which can be reached at an altitude concurrently with Mach 0.7. Fuel tanks cannot be jettisoned, but can be drained in flight through the jettison valve. Average drain time is one minute.

Left engine was pulled to idle at 16,000 ft., then cut off. No yaw was apparent. Directional control, with feet removed from rudder pedals, was excellent. No power was applied to right engine which held to 21,500 rpm. Cleanness of MS 760 was apparent as airspeed slowly dropped to hold even at 180 kt., or 267 mph. TAS.

Turns at varying degrees of bank, both left and right, posed no problems. The airplane has no tendency to spin. In the event it did, loss of altitude per turn is about 1,600 ft. Airspeed was reduced to 130 kt. for air start, which was immediate.

Speed Brakes

Normal descent in the MS 760 usually is made at 21,000 rpm. at 1,000 fpm., speed not to exceed 350 kt. Specifications call for 2,000 fpm. rate for rapid descent, at same power setting and airspeed limitation.

We got down faster by using speed (dive) brakes. Brakes are controlled electrically, with mechanical control available in event of electric failure. Brakes consist of four mechanical plates, one on upper surface and one on lower surface of each wing. They are located in front of the flaps with hinge lines parallel to wing axis. Upper plate opens toward the rear (59 deg. 30 min.), lower plate opens toward the front (65 deg. 45 min.).

Rate of descent with speed brakes was 4,000 fpm. Airspeed was 200 kt.

With full flaps and speed brakes extended, airplane will stall at about 83 kt. In clean configuration, at an altitude of 6,000 ft., MS 760 stalled at 94 kt. IAS.

Safe Flight stick shaker gives ample stall warning, moderate stick buffeting occurring about 5 kt. above stall speed. Excellent aileron control of the airplane was apparent when moderate to steep turns were made at just above stall speed, stick shaking throughout. There was no tendency for wing to fall off.

Docile Airplane

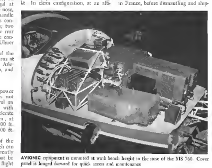
With throttles to idle, and the nose pulled high, there was no sharp break. The nose dropped straight, airplane holding level, and shaking stopped as speed increased, nose then pulling up. The airplane was quite docile. Altitude loss was negligible, and would have been nil with application of power.

Approaching Teterboro, N. J. for landing, speed was reduced to 150 kt. Gear should be raised or lowered at 160 kt. or less. Speed also applies to flap extension up to 20 deg., from 20 to 55 deg. (full), limit speed is 140 kt.

With speed brakes off and gear extended, the airplane was flown downwind at 150 kt. Base leg was flown at 130 kt., flaps lowered to 17 deg. Final approach was made at 100 kt., full flaps. Effective aid in holding approach speed was safe flight speed control indicator, centered above MS 760 instrument panel. Correct speed will center vertical needle. Too low or high a rate will cause needle to deflect left or right, indicating corrective measures.

Touchdown was made at 80 kt., airplane settling in smoothly after roundout. Landing roll was less than 2,000 ft.

All MS 760s are built and test-flown in France, before dismantling and ship-



AVIONIC equipment is mounted at work bench height in the nose of the MS 760. Cover panel is hinged forward for quick access and maintenance.

ment to Beech. Units arrive unpainted, color is added in Wichita. First aircraft was sold to Timken Roller Bearing Co (AW Dec. 2, 1957, p 98). Second delivery, scheduled for next month, is earmarked to a private individual in California.

Beech will accelerate marketing efforts in 1959 and will continue demonstrations for prospects in various sections of North America. Company last month demonstrated the airplane at Pensacola, Fla. in line with the Navy's trainer evaluation program.

Among handling equipment included with each purchase is a wing hoist sling, aft fuselage hoist sling, tow bar, two cradle fixtures, a set of wing bolsters, aft fuselage handling dolly, aileron and elevator rigging fixture, speed brake rigging fixture, flap fixture, rudder rigging fixture, engine handling hoist and engine handling adapter.

Also included are numerous spare parts and supporting equipment, among which are extra tires and tubes, various bolts, rings, connection hose, seals, wrenches, threaded axles, nuts, locks, washers, pins, etc.

In offering the airplane in the United States, Canada and Mexico, the Beech policy stresses full support for customers on spare engines, parts and services. Company stocks both engines and spare parts at its factory.

Soviet's Flight-Test All-Metal Glider

Soviet glider, designated A 11, is all-metal and has a V tail. Aircraft is equipped with devices for in-cloud flying. Maximum speed is almost 250 mph. Glider's wingspan is 52½ ft.

Structure of the MS 760 is simple to inspect, interchange of parts and maintenance can be quick. Nose of the airplane folds forward to expose electronic equipment at work-bench height. Instrument panel hinges aft for work inside the airplane.

Beech emphasizes that both engines may be removed and replaced by four mechanics in 50 min.

Entire rear fuselage of airplane is demounted by removing six bolts. All controls are push pull rods which disconnect without disturbing control rigging. With tail detached, which takes about 15 min., complete engine installation is exposed. Landing gear is mounted to basic airplane structure, which allows ready movement of the aircraft with wings removed. Access hole in fuselage also permits limited engine maintenance.

Fuel is fed to Marbore 2C engines via two submerged pumps located at the lower part of fuselage tank. If there is less than 238 gal. of fuel in the fuselage tank, the fuel level control valve is opened and fuel is forced from tip tanks by compressed air to fuselage tank where the level is maintained constant during the transfer process.

Airplane's hydraulic installation is limited to the brake system. There is no emergency braking system. MS 760's electrical installation operates on direct current of 28v. It is a single wire system with ground return through the structure. Nickel cadmium battery is of 24v. and 35 amp hr capacity, located in the fuselage nose. Two inverters supply three phase, 400 cycle, 115v. alternating current.

Gear is retracted electrically, with manual extension in event of electrical system failure. Flaps, dive brakes, horizontal stabilizer adjustment, aileron tab control and canopy control also are electro-mechanical.

Airplane is pressurized from second bulkhead forward of cockpit to just aft of cockpit. Pressure tightness between canopy and fuselage and between upper and lower inspection doors is via inflatable rubber seals. Seals are inflated by air bled from the engines. For temperature control of cabin, hot air bled from engines is sent directly into cabin.

If cold air is wanted, air bled from engines is sent in a boot strap air cycle cooling system, then to the cabin.

To avoid moisture on windshield and side windows, all conditioning air can be directed toward defogging outlets. In normal operation, a part of the conditioning air goes directly on the windshield, the rest going to the foot air distributors.

In event of ventilation system failure, the cabin may be ventilated through an outside air intake located in high pressure area in front of windshield. Door opening is controlled from the pilot seat. In case of pressure regulator failure, vacuum pressure relief valve offsets dangerous pressures. Should cabin pressure go below outside pressure, the valve brings cabin pressure back to outside pressure.

In event of complete electrical system failure, landing gear, brakes and canopy will be used with emergency controls. Landing will be made without flaps.

WHO'S WHERE

(Continued from page 15)

Changes

C. M. Christenson, assistant vice president-flight operations, United Air Lines, Inc. Also **J. J. Davin**, appointed to the staff of the vice president-marketing.

Robert R. Heller, director engineering and sales-ground support systems, Southern California Aircraft Corp., Ontario, Calif.

Robert Kinkead, assistant to the vice president and sales manager, Republic Aviation Corp., Farmingdale, N. Y.

C. B. Smith, customer relations manager, Electronics Division, Ryan Aeronautical Co., San Diego, Calif.

William J. Schoenberger, manager-weapon systems projects, Defense Electronic Products, Radio Corporation of America, Burlington, Mass.

Harold J. Huber, section manager-radar systems research, and **Murray Hoffman**, group supervisor-microwave networks and antennas, Government and Industrial Staff Research Division, Philco Corp., Phila.

Dr. Steven Yurenka, manager, Advanced Structures Research Laboratory, Research & Development Division, Narmco Industries, Inc., San Diego, Calif. Also **Harold H. Levine**, research chemist for the Division.

Harold K. Hatfield, Western regional sales manager, Kinlock Division, Kaynar Mfg. Co., Inc., Rivera, Calif.

William C. Bohn, director of technical information, Industrial Acoustics Company, Inc., New York, N. Y. Also **Dr. Uno Ingard**, staff consultant-research and development for the company's aeroacoustics laboratory.

Dr. Donald G. Wilson, general manager, Electronics Division, Stromberg-Carlson Division of General Dynamics Corp., San Diego, Calif.

Landis Carr, customer relations representative, F-27 program, Fairchild Engine and Airplane Corp., Hagerstown, Md.

Philias H. Girouard, development coordinator, Consolidated Electrodynamics Corp., Pasadena, Calif. **Henry S. Black** succeeds Mr. Girouard as director of the DataTape Division.

Aerojet-General Corp., Azusa, Calif., has announced the following appointments: **Dr. George Muc**, head of the corporation's Astronautics Laboratory; **Raymond J. Melchiore**, flight test center resident representative at Edwards AFB; **Wilbur G. Clayton**, logistics coordinator, Titan weapons system program, Turbo-Machinery Division; **William Mullock**, general purchasing agent.

Samuel J. Davy, manager of field operations, Arma Division, American Bosch Arma Corp., Garden City, N. Y. Also **Karl H. Keller**, site manager of the Arma Division's Cape Canaveral Operation, Air Force Missile Test Center, Fla.

Richard N. Schuck, director of the newly established Marketing Research Department, Marketing Division, Consolidated Electrodynamics Corp., Pasadena, Calif.

William M. Shultz, special assistant to the manager, Pilotless Aircraft Division, Boeing Airplane Co., Seattle, Wash.

Robert L. Schroeder, general sales manager, Pesco Products Division, Borg-Warner Corp., Bedford, Ohio.

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Contact—Floyd E. Hargiss, Manager Professional Personnel
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IN SUNNY SAN DIEGO

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IDEAL LOCATION

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SEND RESUME

Please send resume of your qualifications at the earliest opportunity to Louis Klein, Dept. E-332, Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, Calif.

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Chief of Aerodynamics
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METALLURGISTS • PHYSICAL CHEMISTS • SOLID STATE PHYSICISTS • CERAMISTS

ARE YOU OVERLOOKING SOME OF THE MOST CRITICAL CHALLENGES IN THE MATERIALS FIELD?

Listen in on this interview with Dr. A. E. Focke, Manager Materials Development at General Electric's Aircraft Nuclear Propulsion Dept., Cincinnati, Ohio

Q. ***Dr. Focke, I have heard it said that the Aircraft Nuclear Propulsion Program adds a new dimension to materials technology. Do you agree?***

A. Strictly speaking, Mr. Welsh, reactor development for any application may be said to do this, since materials must be selected for their nuclear as well as their physical properties.

For some applications we look for high neutron absorption cross sections; for others, low capture cross sections.

For example, the material selected for the moderator must be capable of slowing down the neutrons produced by fission to thermal energy, about 1/40 ev from their original energy of several million ev with a minimum loss of neutrons by parasitic capture. Control rods on the other hand, must have high capture cross section for neutrons.

In practically all material applications for the nuclear power plant for aircraft which we are developing here, however, we have a high temperature problem of dimensions unique in materials technology.

Q. ***Why is that, Dr. Focke? Aren't these problems similar to those already solved for marine nuclear propulsion?***

A. In the ANP program weight and size are severely limiting factors. Here we are dealing with a small, high density reactor a small fraction of the size and weight of the submarine reactor. To jam high energy into small volume requires the development of high temperatures. Generally the higher the reactor exit air temperature, the better the overall performance of the power plant.

The crux of the problem here is the fact that common materials desired for some parts of the reactor for nuclear considerations, cannot operate at the maximum temperature of the over all system.

These charts prepared for a recent paper will give you a better conception of the materials problem. Fig. 1 summarizes the general requirements. Figs. 2, 3 and 4 review a few of the basic physical properties of each of 11 metals selected for discussion.

Q. ***Can a materials man work effectively at ANP without previous training in nucleonics?***

A. Certainly. All the orthodox skills of the metallurgist, ceramist or chemical engineer are called into play here. The Aircraft Nuclear Propulsion Department will provide necessary training and information in nucleonics.

Q. ***What you've just told me, Dr. Focke, I certainly can discern the challenge to the materials man that you have here. I suppose you are working with alloys of some of the more exotic metals so much discussed in the latest technical literature?***

A. Security limitations forbid my naming specific materials on which we are concentrating our investigations at this time. We have, however, made considerable progress, though a great deal of work remains to be done before our first high performance nuclear power aircraft makes its maiden flight.

One of our principal problems is to be sure we have people with the required technical competence and specific abilities to function effectively.

Component	High Strength At High Temp	Ability to Resist Oxidation	Neutron Absorption Cross Section	Density	Special Requirements
Fuel Elements	x	x	Low	—	Compatibility with fuel
Moderator	x	c	Low	Low	Ability to slow neutrons to thermal effectively
Control	x	x	High		
Shield					
a. Gamma	c	c	—	High(1)	(1) Ability to attenuate γ.
b. Neutron	c	x	High(2)	Low	(2) Ability to absorb without producing γ

FIG. 1

Some characteristics of 11 metals in relation to possible application in Nuclear Power Plant for Aircraft—prepared by Dr. A. E. Focke, Manager, Materials Development.

Thermal Neutron Absorption Cross Section in Barns		Melting Point—°F		Crystal Structure		Allotropic Transformation
1. Hf	105.0	1. W	6116	1. Re	h c p	NONE (known)
2. Re	84.0	2. Re	5756	2. Hf	h c p	b c c 3020°F
3. Ta	21.3	3. Ta	5426	3. Ti	h c p	b c c 1620°F
4. W	18.2	4. Mo	4752	4. Zr	h c p	b c c 1584°F
5. U	7.68	5. Cb	4474	5. Th	f c c	b c c 2425°F
6. Th	7.4	6. Hf	4032	6. W	b c c	NONE
7. Ti	5.6	7. V	3452	7. Ta	b c c	NONE (known)
8. V	5.1	8. Zr	3375	8. Mo	b c c	NONE
9. Mo	2.5	9. Th	3308	9. Cb	b c c	NONE
10. Cb	1.1	10. Ti	3020	10. V	b c c	NONE
11. Zr	0.18	11. U	2071	11. U	alpha	tetra 1220°F b c c 1427°F

FIG. 2 FIG. 3 FIG. 4

Metallurgists, ceramists, physical chemists, solid state physicists with background in hi-temperature materials are invited to inquire about professional opportunities in these areas. Nuclear experience, while desirable, is not essential.

Write in confidence including salary requirements to: Mr. P. W. Christos, Professional & Technical Personnel—Division 58-WZ

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LETTERS

Technical Lag

You are to be commended for your editorial of Dec 1, "The Soviet Nuclear Powered Bomber," concerning our lamentable technical lag. Our scientists and engineers too long have been handicapped by an unthinking penny pinching Administration. The United States rests upon its outdated scientific laurels much like a complacent hare, while the Russian tortoise moves far ahead.

What value will a balanced budget have in a world dominated by communism?

Let me take this opportunity to congratulate the editors and staff of AVIATION WEEK on their excellent coverage of all matters relating to the field of aviation.

The above mentioned editorial and report on the Soviet nuclear bomber are typical of the high quality reporting found in your magazine.

W W ROACH
Ft Worth, Tex

'Incessantly Slanted'

I find your repeated editorials like "The Need to Know" (AW Nov 24 p 21) somewhat redundant, tiresome, and illogical. They are, of course, incessantly slanted toward unlimited aviation (and now outer space) expenditures.

You say you haven't been able to understand the philosophy that we can't "afford" (presumably the quotations mean this is a dirty word) expenditures that are required for adequate military strength and technical development of new weapons. You further say that a limit of $15 billion annually was labelled the absolute maximum that could be spent just before Korea and that subsequently we spent triple and quadruple that limit.

This is not an honest argument. We did not "spend" the money for this crisis—we "borrowed" it. To highlight what these expenditures are doing to us I quote only one paragraph out of 10 recently written by Mr Lyle C Wilson, of United Press International on the subject. He says, for example: "If the national debt increases in the next 30 years as it has in the past 30 we all would be busted by 1989. By that year we would all be earning dollars which wouldn't be earning much of anything. For a real switch, it would probably be easier then to earn deflated dollars than to spend them." I commend the entire article to you.

Bankruptcy happened in Germany it happened in China and the Communists want it to happen here. (It's another thing they've said in so many words.) Bankruptcy paralyzes capitalistic during power in military and international matters just as surely as it paralyzes domestic life. Communism uses every stratagem in every important sphere—military, economic, sociological, psychological and ideological—to attain its purpose to destroy us. This must be President Eisenhower's sole purpose in establishing the checks which he is forced to establish. Certainly he knows the importance of "adequate" national defense and development of new weapons after living the life of a professional soldier. (And he is now in a better position to know what is "adequate" in our defense. He must know this even better than those in the civilian magazine business.)

This brings me to my next observation regarding another religious point of yours. This is your public "need to know" principle.

As you put it, the public has a "need to know" about how its tax dollars are being spent. This, being a part and parcel of the previous arguments, implies that the detailed plans of our national defense should be open to the world. This is a bit hard to understand since we have already been laughed at the world over for not being able to control our classified information. This "freedom" HAS ASSISTED THE ENEMY IN BUILDING EVERYTHING FROM ATOMIC BOMBS TO HELICOPTERS. Certainly even you gentlemen of the press must agree that the intelligence factors used as a basis for national defense would benefit the enemy. There has to be some time when we trust the judgment of those in high places when we know it's based on information that can't be common knowledge. It's time the freedom of the press was properly used—not abused. It is an abuse to cast general skepticism on our government "men in high places." Democracy has plenty of checks and balances even where classified data is concerned. The President and key officials are checked by Congress, the National Security Council, and the Department of Defense to mention a few.

Let's have support for them rather than the destructive innuendoes designed to sway opinion toward vested interests.

One final word on the "gagging and muzzling" of military men. By their very profession military men are devoted to discipline which ensures teamwork and cohesion. This predominant trait of military life has proved itself as a life and death necessity through the ages. No military man is "gagged or muzzled" within the corporate body. He is free to express his views long and loud within the Department of Defense and in confidence within that Department. His views are given every consideration. Decisions are then made by the President taking all views and factors into consideration. Some of these factors are not well known to the partisan complainers. Once the considered judgments have been made by the President all true military men in traditional discipline, conform and support the decisions.

Your alternative of free rein to public controversy between partisan opinions of various military men who think they and they alone know all the answers would guarantee military chaos.

This country must somehow face the fact that we are fighting a daily encounter with an enemy who is committed to destroy our systems and dedicated to creating distrust, confusion, and lack of discipline within our ranks. Leadership of our present government has never been better and we can be thankful that we've had it in these past critical years since Russia acquired atomic capabilities. As advocates of government for the people and by the people, we the people also have a heavy burden of responsibility to give strong support to our popularly chosen "government men in high places" rather than continually sniping at them once they are in office.

And don't forget that under the Communist system you'd only write one and final editorial like "The Need to Know."

J E HART
Monterey, Calif

(May we remind reader Hart that bankruptcies in Germany and China followed disastrous military defeat and reiterate Sen Stuart Symington's oft repeated statement that a balanced budget never stopped an enemy tank, bomber or missile.—Ed.)

Jet Restrictions

Your U S airline officials' "yelp" about the Port of New York Authority restrictions on jet operations from Idlewild (AW Oct 13 p 37) are understandable, they hit his pocket. He will, of course, realize that he is merely repeating the howl of "American discrimination" in sections of the English press about six years ago when the Comet I met similar trouble.

I feel, as a distant observer, that the Port of New York Authority deserves applause on two counts:

(1) They appreciate that the rights of a community transcend the rights of a specific group.

(2) They, only, have formulated definite requirements thereby clarifying the position for both manufacturer and operators.

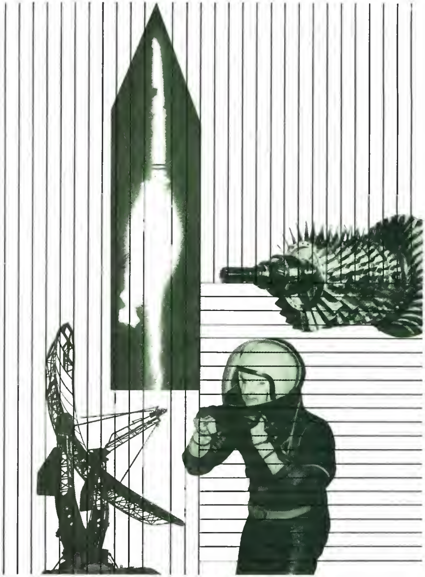
T F HARVEY
67 Spencer St
Essendon W 5, Australia

Orbiting Name Tags

The detailed information you have published on the USAF moon shots has been most educational. The design of the payload stage in particular is very interesting. There has obviously been an expenditure of considerable effort to achieve a light efficient structure. This effort is certainly mandatory when one considers the extreme ratio of launch to payload weight required to achieve a lunar orbit.

I was somewhat surprised to note the presence of a neat little metal nameplate on each item of instrumentation (AW Nov 17 p 29). I am certain that if one computes the cost of orbiting these name tags it will be concluded that this is one application in which they should be dispensed with.

ARTHUR NITIKMAN
Los Angeles, Calif



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